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NATURAL HISTORY

THE JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

VOLUME LXXIX
1970

Published by
THE AMERICAN MUSEUM
OF NATURAL HISTORY
NEW YORK, N.Y.

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SPECIAL 32-PAGE REPORT ON MANKIND:
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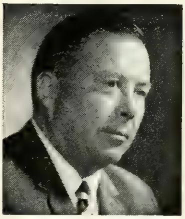
HOW MEN AND WOMEN CAME TO LIVE TOGETHER

THE SHY GRIZZLY

READING THE STARS WITH THE SKY REPORTER

seal harems
A MATTER OF LIFE AND DEATH

David P. Reynolds tells how we can "mine" tons of aluminum from our scrap heaps-and fight litter



Aluminum's scrap value makes it worth collecting and "re-cycling"...

There are two national problems which we believe no materials producer should ignore: litter and conservation. Fortunately, because of the nature of our metal, aluminum, Reynolds has been able to develop some answers in both areas.

Indestructible aluminum is re-usable

First of all, aluminum has scrap value; and it is virtually indestructible. It resists corrosion and will not rust. It can be remelted, re-alloyed, and re-used—economically. And the need for and uses of this strong, lightweight metal seem to multiply yearly. So a used all-aluminum beverage can is worth something; it is worth picking up and "re-cycling." If this suggests a way to fight litter to you, it did to the men at Reynolds, as well. We are now testing different approaches in two cities, Los Angeles and Miami, and plan to try others in the future.

Using aluminum's scrap value

Our idea is to encourage community groups to sponsor aluminum can collecting drives, and earn money for worthwhile causes and for their own needs.

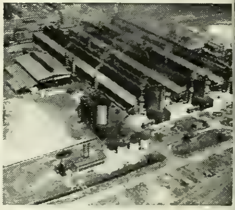
As they raise funds, they help keep their streets, parks, and beaches free of litter. Aluminum scrap does offer a worthwhile incentive to such organizations: a ton of aluminum, for example, brings $200 from dealers, compared with $20 for steel and $16 for waste paper. This scrap value is something many industrial users keep in mind when they specify aluminum equipment. They know there's a bonus waiting at the end of the service life of this equipment.

Mines—not scrap heaps

Although there is an abundant supply of aluminum for the foreseeable future, the fact remains that the supply is not unlimited—and aluminum usage has been doubling roughly every ten years. But this need not be a problem if we capitalize on the re-usability of aluminum. Already, an estimated 30% of the world's aluminum is reclaimed or secondary metal. This could be even higher.

Countless products provide "mines" of aluminum, ready to be tapped. Not only aluminum cans and packages, but the aluminum in appliances, automotive parts, building products, even railroad cars can and should be reclaimed when they've finished their useful service.

Scouts and many other organizations fight litter and raise money by collecting all-aluminum cans.



Reclamation plants which produce aluminum from scrap help to conserve our natural resources.

New Reynolds reclamation plant

We at Reynolds have launched our effort toward this goal—not only with our anti-litter can collecting programs, but with a major investment in reclamation facilities. (An additional reclamation plant will be producing aluminum from scrap in 1969.)

Efforts such as these, we believe, will do much to reduce the solid waste disposal problem, and help stretch our natural resources. *Reynolds Metals Company, P. O. Box 2346-LII, Richmond, Virginia 23218.*

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ALUMINUM

aluminum

NATURAL HISTORY

L. LXXIX, No. 1 INCORPORATING NATURE MAGAZINE JANUARY 1970

THE JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

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How man has survived within the confines of an island may be the key to how man can survive within the confines of the earth.

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The natural shyness of this recently maligned animal is his greatest defense against man—and vice versa.

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Publication Office: The American Museum of Natural History, Central Park West at 79th Street, New York, N.Y. 10024. Published monthly, October through May; bimonthly June to September, Subscription: $7.00 a year. In Canada and all other countries: $7.50 a year. Single copies $1.00. Second-class postage paid at New York, N.Y., and at additional offices.

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Histor

This is the biggest ship ever to be launched sideways.

She's the Esso San Francisco, hitting the Mississippi at Avondale, Louisiana, last July. And two 76,000-ton sister ships, also ordered by Jersey's affiliate, Humble Oil & Refining Company, will follow her act in the next few months.

228,000 deadweight tons of ships. It's a big order. And it's only part of Humble's current shipbuilding program in the U.S.

Elsewhere around the world, Jersey's affiliates are making shipbuilding news.

At the beginning of this year, there were 33 tankers on order in nine different countries. Nearly five million deadweight tons. An investment of over $400 million.

This, the biggest tanker-building prog
in Jersey's history, is necessary to mee
world's ever-growing demand for oil.

And there are some heart-warming st
to tell. For example, at Wallsend in Englar

Two years ago, Jersey's British affil
Esso Petroleum, decided to build two mamn
253,000-ton tankers at Wallsend. Then the
est ships ever to be ordered in Europe.

"It's the best news this town has ha
years," said Wallsend's mayor.

The Esso Petroleum order guaranteed
years' employment for 3,000 men. It pu
million a year in wages into the town's e
omy. And now you can see the effect. M
goods in the shops. More cars on the str
More smiles in the pubs.

lashdown.

3ehind this news is an encouraging story.
)nly seven weeks before Esso Petroleum
d its order, no British shipyard was in the
ng either for price or delivery date. And
ery date was particularly tough. Two ships,
bigger than the Queen Mary, to be finished
o years. And ten unions were involved.

The initiative came from the unions them-
s. They negotiated agreements that
ed one trade to pitch in on another's job.
more a worker produced, the more he
ed. When they and the shipbuilders were
the job could be done, the banks responded
low-cost loans.

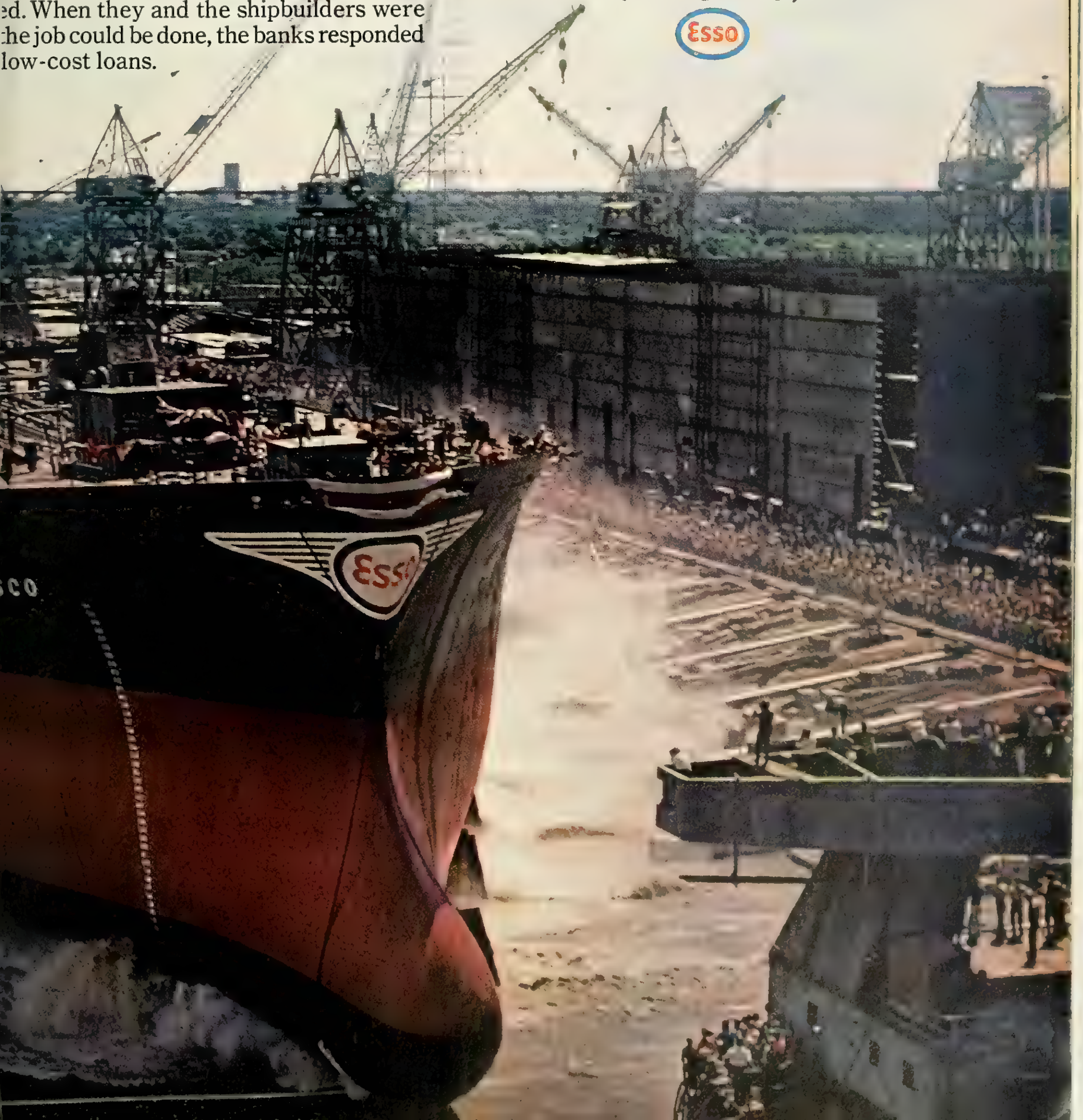
Now Wallsend has more ships on order than anyone could have foreseen.

In fact, since Esso Petroleum broke the ice, there are twenty-one ships to be built there, including a third giant tanker.

We like to think that the splash we made at Wallsend was, in its own way, as historic as the one we made on the Mississippi.

Standard Oil Company
(New Jersey)

Esso



THE AUTHORS

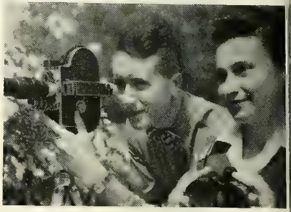
"How Men and Women Came to Live Together," was written by **Aniceti Kitereza**, a seventy-four-year-old Kerebe of Ukerewe Island, Lake Victoria, Tanzania (additional biography, page 18), and brought to the attention of NATURAL HISTORY by **Gerald** and **Charlotte Hartwig**. Mr. Hartwig, a candidate for the doctoral degree in African studies at Indiana University, received a Foreign Area Fellowship for the purpose of reconstructing Kerebe history from its oral traditions. During their eight-month stay on Ukerewe Island, the Hartwigs assisted Mr. Kitereza in the translation of his story, first into Swahili and then into English.

The "Naturalist at Large" this month is **Margaret Mead**, whose article, "The Island Earth," sets the keynote for the NATURAL HISTORY Special Supplement, "The State of the Species: 1970." At present, Dr. Mead is curator emeritus of ethnology at The American Museum, adjunct professor of anthropology at Columbia University, and chairman of the social science division of the Liberal Arts College at Fordham University's Lincoln Center campus.

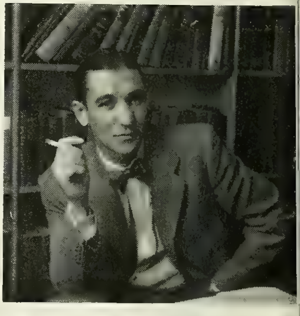
Charles A. Whitney, who received his Ph.D. in astronomy from Harvard University in 1955, is professor of astronomy at Harvard and a physicist at the Smithsonian Astrophysical Observatory. A specialist in stellar atmospheres, Dr. Whitney has recently completed a textbook on this subject. His projected studies include a history of the astronomical discoveries leading to the recognition of the Milky Way as a galaxy.

Richard K. Mathews' article on northern fur seals is the result of a recent ten-day expedition to the Pribilof Islands, where he observed the life styles of both humans and seals. The author of *The Yukon*, for Holt, Rinehart & Winston's "Rivers of America" series, and of various articles, mainly political, for *Saturday Review*, *Reporter*, and *New Republic*, Mr. Mathews has traveled in the Congo, Angola, and French-speaking Africa as a fellow of the Institute of Current World Affairs and as a free-lance writer. He is currently at work on a book about Alaska, part of a series on regions of America, which will be published by Harper & Row.

"Evergreen Review," by **Lorus J.** and **Margery Milne,** is the latest of several articles and reviews they have written for NATURAL HISTORY. Dr. Milne is professor of zoology at the University of New Hampshire where Mrs. Milne is a lecturer in nature recreation. Together, they have traveled over 660,000 miles on expeditions in North and Central Americ
the West Indies, Surinam, Europ
Africa, the Near East, Southea
Asia, eastern Australia, New Ze
land, and the Pacific Islands. D
Milne has been a consultant f
UNESCO in New Zealand, a Fo
Fellow in conservation, and a Rock
feller Fellow at Scripps Institute
Oceanography. His current researc
interests center on the role of visio
in normal behavior and on ecolog
particularly among invertebrate an
mals. The Milnes are coauthors
Living Plants of the World, *The Ag*
of Life, and *Patterns of Survival*, a
well as of twenty other major book



A. Starker Leopold's associa
tion with the University of Californi
at Berkeley spans twenty-four yea
of scientific and administrative wor
Presently professor of zoology (sinc
1946) and of forestry (since 1967)
Dr. Leopold was assistant to th
chancellor, Berkeley campus, 1960 t
1963, and associate director of th
Museum of Vertebrate Zoology, 195
to 1965. The recipient of a Guggenheim Fellowship and the Audubo
Society Medal among other honors
Dr. Leopold has done field work in
Mexico, the Missouri Ozarks, Alaska,
Australia, and East Africa. He is the
author of *Wildlife of Mexico*, honored by the Wildlife Society as the
"Best Wildlife Publication" of 1959



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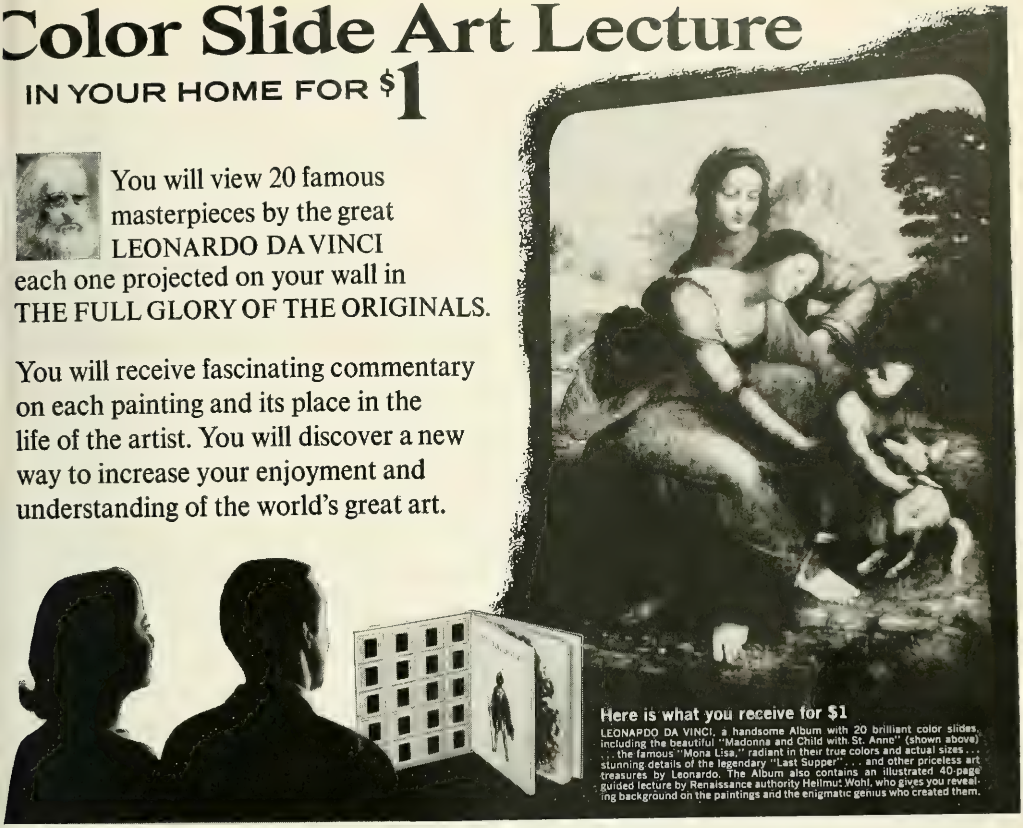

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The color slides, however, are only one part of the Album. Bound into the center of each Album is an illustrated 40-page guided lecture which discusses the artist's life as well as each of the 20 paintings presented; its place in the development of the artist, its importance in the history of art, its reflection of the tastes and attitudes of the period.

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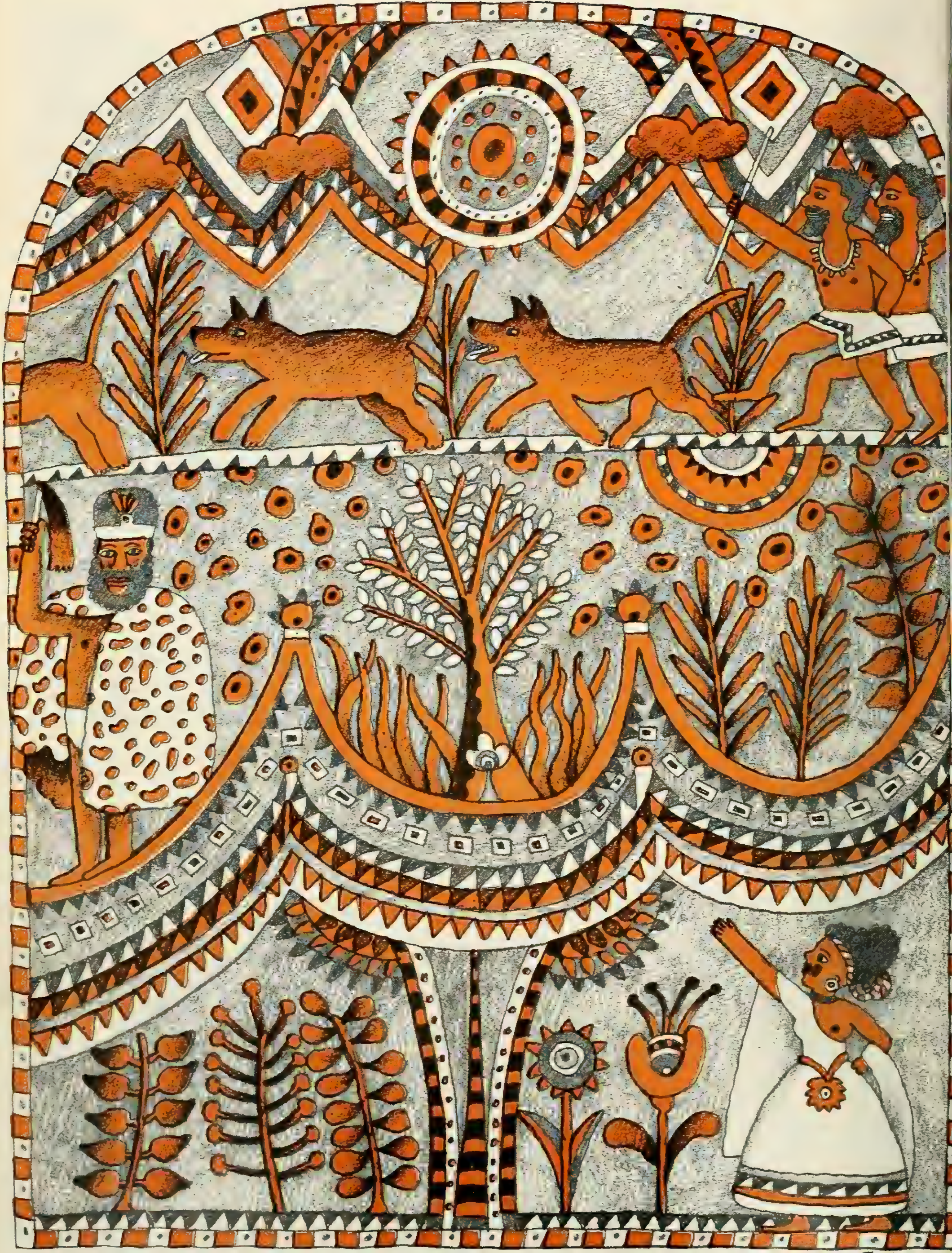
Talach

A Kerebe Tale

How Men and Women Came to Live Together

by Aniceti Kitereza

Now listen and I will tell you an old story so that you may know what made us live with women. In the beginning, all men lived together in one country with their Chief. They cultivated grain that they used as food, but they never ate meat. At this same time, women lived in another country with their Queen. The women did not know how to cultivate grain, so they ate only meat. The Queen had trained one hundred dogs that would help her women catch wild animals for their meat supply.

One day the Queen sent for her Headwoman and her messengers and said: "Go to the men's country to greet their Chief. See if those people are peaceful and bring me news from them."

The women immediately set out on their journey carrying a great amount of meat for their food supply. After sixteen days they arrived in the men's country. When they found the Chief and greeted him, they were warmly welcomed. The Chief gave them a room for sleeping and then sent food for them to eat. But when the women saw the *obwita,* "stiff porridge," and greens they were astounded and exclaimed: "But what is this? We never eat such food in our country! It is taboo for us."

This was a great surprise to the Chief and his men, for they were not aware of other eating customs. And so with great interest they asked the women what they ate.

"We only eat meat," they replied.

"And we never eat meat here," said the men, "for it is taboo for us. How do you manage to capture the wild animals?"

"Our Queen has trained one hundred dogs. These dogs are very clever, and they catch the wild animals for us."

Now this was pleasant news to the Chief for he was constantly harassed by wildlife that destroyed his crops. Suddenly he had an idea.

"Could your Queen lend me her dogs so that we might be rid of these pests who rob us of our food and ruin our grain?"

"Surely, she will gladly do so."

"How many dogs do you think she could spare?" the Chief inquired.

"Perhaps she will lend you all of them, but of course, we cannot answer for certain until you have requested the Queen personally."

"Very well. My men will return with you to your country to see if this can be arranged."

After a few days' rest, the women bid farewell to the Chief and, accompanied by the Chief's messengers, set out on their return journey. When they reached their own land once again, they went to the palace to greet their Queen and to present the Chief's envoys. After the Queen had welcomed the guests, the women began to tell her all that had transpired during their stay in the men's country. When they related the incident concerning the food given them, all the women who had gathered at the palace shook with laughter to hear of such an outrageous custom. Eager for details, they asked for more information concerning this strange food.

One of the Queen's messengers began to explain: "There are some rootlike plants that are round in shape. They are called *enumbu,* 'sweet potatoes.' And there are other plants like trees called *amalibwa,* 'cassava, or manioc.' There are also some grasslike plants and when they have been dried and harvested, the grains are separated from the stalks. This pure grain is called *oburo,* 'millet.' It can be stored in a special house until the men need it. Then it is put on a grinding stone and ground into flour. Water is boiled and the flour is added until it is very stiff and the large wooden ladle cannot stir anymore. This solid thing is called *obwita.*"

When she had finished, everyone was astounded at her tale and they said: "To live is to see many strange things. We thought those men were just like us. Lo and behold, they even eat the grains of grasses, like animals!"

The Queen then summoned the men to her and finding it hard to believe that they really ate in the manner described by her messenger, she asked if this could possibly be true.

"It is true indeed," they replied, "for to eat meat is taboo for us. We are constantly bothered by wild animals in our country. They destroy our crops and are very troublesome. We have tried to kill them, but so far we have had no success. And that is

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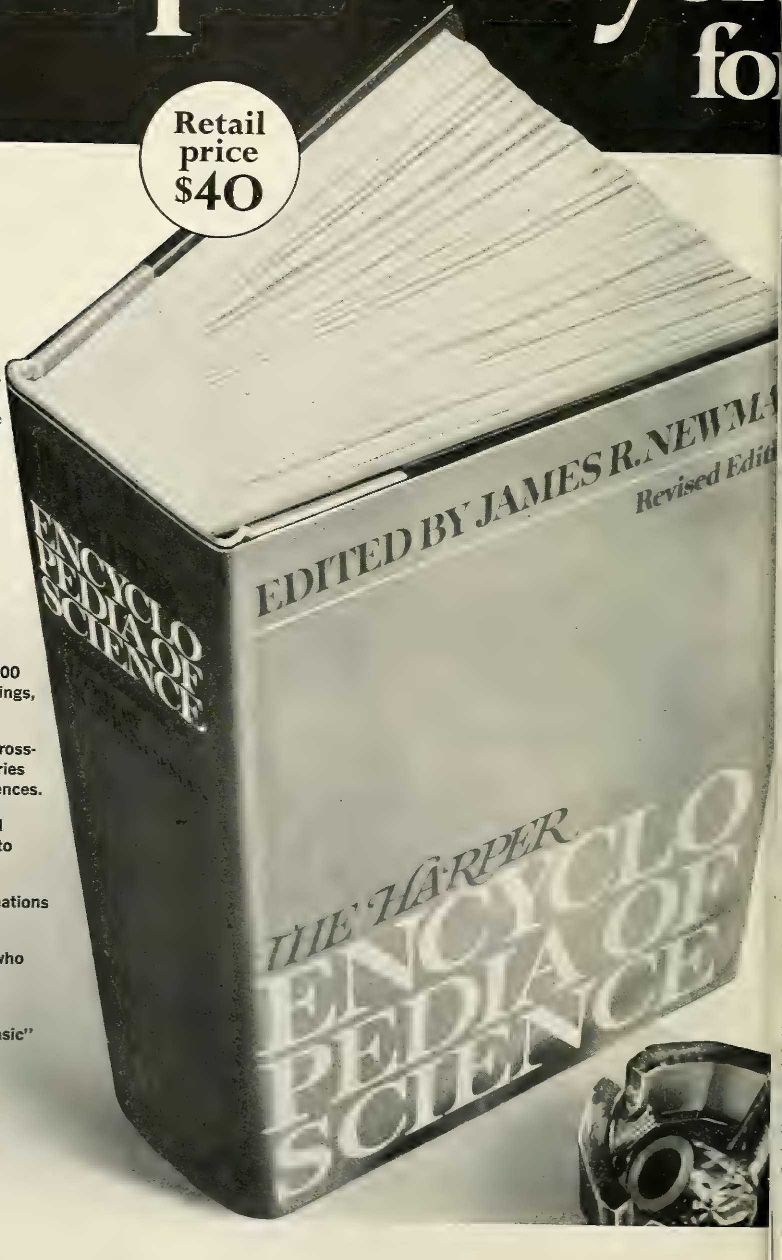

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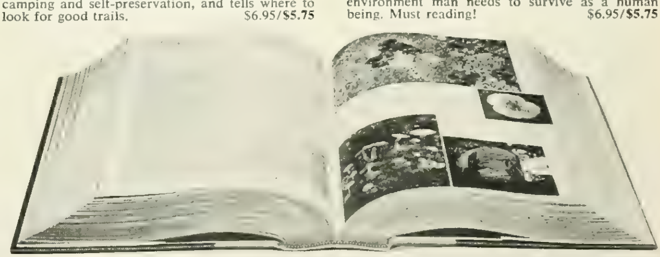

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why we are here. Your women told us that you have trained some one hundred dogs. Our Chief therefore requests permission from you to borrow these dogs for a short time so that we might rid ourselves once and for all of these pests."

This proposal came as something of a surprise to the Queen, but after consultation with her Headwoman she agreed.

"Very well, you men, you may use our dogs. But as we must hunt meat for the time you will be gone, it will be necessary that you remain with us for a few days."

Full of gratitude the men thanked her saying, *Kasinge Izoba, kasinge ntale, kasinge namuha,* "Thank you the sun, thank you the lion, thank you the one who gives."

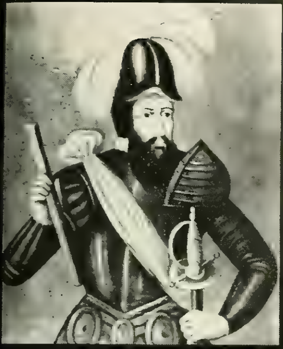
Early the next morning, the men were awakened by the sounds of sharp, shrill whistles, horn flutes, and dogs barking. Rushing outside from their sleeping room, they saw that all the women were assembled at the palace waiting for the signal from the Queen to begin their hunt. At her command, they dispersed with the dogs, and the men did not see them for the whole day.

In the evening, once again the men heard the sounds of whistles, flutes, and barking dogs. When the women reached the palace, the men could see that their arms were full of meat and that the dogs' mouths were covered with blood.

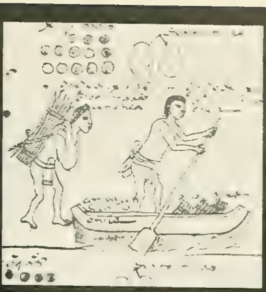
Later, the Queen met with the men and advised them to depart early in the day as their journey would be long. Then she warned them:

"There is one very important thing for you to remember. My dogs are to be orderd to attack only once like this, 'Chi!' If you should forget and order them twice or three times, all the dogs will disappear and no one will ever see them again. My women have learned this well: I can trust them completely. Now I implore you to take this warning to heart. Tell your Chief so that he can give this information to the men who hunt with my dogs."

With these words still ringing in their ears, the men departed the next morning at the first sound of the cock's crow. They left with the dogs, the whistles, and the flutes for hunting. When they reached their own country once again, the Chief and a large crowd of men were awaiting



Pizarro rose from Spanish peasant to master of Peru before being murdered by his own men.



This drawing details the age, tortilla ration and duties of an Aztec child.

A Maya aristocrat strikes a pose suited to his station in life.

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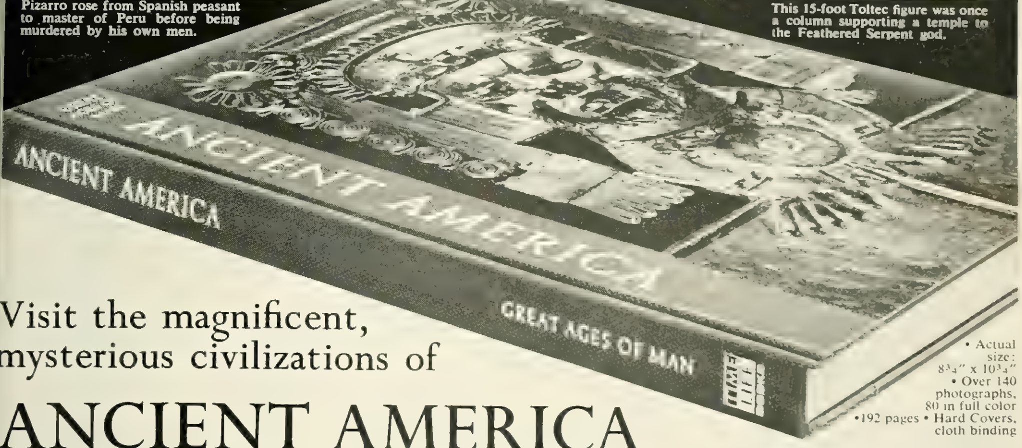

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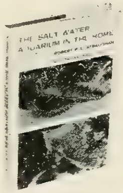

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them, eager for news of the trip. After kneeling in greeting to the Chief, one of the head messengers, Nkubitizi, began his tale:

"Oh, Chief, we return from a safe journey. Even at our camping sites we had no difficulties. When we arrived in the women's country, we found the Queen to be quite magnificent. She welcomed us warmly and gave us a room for sleeping. But when the women brought us our food, you can imagine our amazement—they brought us nothing but meat!"

Everyone gathered at the palace was listening intently to Nkubitizi's words. And as he described the meat the women brought them, they were so astonished that some of the men were on the verge of vomiting.

Nkubitizi continued. "Your request for the dogs has been granted and we have brought all one hundred of them. During our visit with the Queen, she showed us how to use these dogs for hunting. She has given us her whistles and small flutes as well. But now you must all listen, for I have a very important message from the Queen. These dogs have been trained to attack with the command, 'Chi!' But this order to attack must be given only once, not twice or three times. If anyone of us should forget this warning, the dogs will disappear forever."

Everyone listened gravely to these words and assured the Chief that they would not forget them.

The Chief, anxious to see everything that his men had brought him, ordered Nkubitizi to bring the flutes and whistles. He examined them with great interest.

"And what is this feather for?" he inquired.

"It is to clean the flute before blowing it."

"Show me how to play it."

"But if I blow it now," explained Nkubitizi, "the dogs will hear it and get set for hunting without their leashes. The Queen has warned us to only use these instruments on our way to a hunt and on our return home."

Hearing this, the Chief ordered all his messengers to inform each Headman that on the next day there would be a hunt and all men should meet at the palace. He was eager to try out the dogs and whistles and flutes.

Early the next morning when the Chief had awakened and washed himself, he left his sleeping house. In the courtyard he was very surprised to find only twenty men with Nkubitizi.

"And where are the others?"

"Perhaps they have slept long after a weary journey."

"Ah, then beat the drums so all may hear that the time is at hand to begin the hunt."

And, truly, as soon as the drums could be heard, men suddenly appeared from every direction. It was a joyous occasion as if it were a celebration day. The leashes were put on the dogs, the instruments were in readiness, and the men were jumping and shouting with excitement.

After Nkubitizi quieted the crowd, the Chief exhorted his men.

"To all who have come here, you know of the damage done to our crops by wild animals. Today we have one hundred dogs owned by the Queen from that other country. She has lent them to us so that we might have success in killing the animals. Now listen carefully. These dogs have been well trained. When the time comes you must order them only once to attack like this, 'Chi!' You must never order them twice or three times or they will disappear forever!"

Nkubitizi then led the men on the hunt with whistles and flutes blowing and dogs barking. When they reached the jungle, the dogs were ordered to attack: "Chi!" shouted the men, and the animals scattered all over with the dogs in pursuit. By late afternoon, all the animals in the area had been killed, even small ones in holes had been carried off. A report of the hunt was given to the Chief who was pleased indeed with the news. But as he wanted to see this with his own eyes, he asked Nkubitizi to show him the place where they had hunted. When they reached the jungle and he viewed the array of dead animals, he was truly astonished.

The Chief was then eager for another hunt, and two days later Nkubitizi organized the men once again. The excitement of the hunt was heightened with the whistles and the flutes blowing and the dogs barking. But it is the nature of men that when many are together, some forget themselves, and this is exactly what happened. Some of the men

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ordered the dogs to attack more than once. And just as the Queen had predicted, the dogs disappeared.

Now Nkubitizi and his men were very frightened for they feared the Chief's anger. Surely he would kill them! But when the Chief heard the news, although he was greatly disturbed he spared the men since there were so many at the hunt.

By this time the Queen's meat supply was dwindling and since she had not heard any news from the men she called her women together at the palace.

"Listen, ladies," she said, "tomorrow we shall all leave for the men's country and get our dogs. Our meat supply is so low, surely we will starve if we are not able to hunt soon. Our kindness has only caused trouble. Let us not delay one more day."

Early the next morning the Queen ordered her Headwoman to beat the royal drums, *matwigacharo*, "ears of the country," so that her whole chiefdom would hear the summons. As the women began to gather at the palace they knelt first in greeting to the Queen, clapping their hands and saying: *Habuka rwena, Habuka isaza. Habuka bwonga mwoyo, Habuka muzurambi.* "Honored one who gives, who builds, who joins the hearts of all people."

The Queen was dressed in a splendid copper dress that shone brightly in the sun. As they prepared to leave, a seat made of buffalo skin, with the nerves of the buffalo's back legs used to fasten the chair to poles, was brought for the Queen. In this way, the women could carry the Queen, as her dress was heavy and cumbersome. Other women began to play their flutes and when at last all the Queen's subjects were assembled, they formed a long procession.

Two days prior to their arrival in the men's country, the Queen sent twenty women as emissaries to the Chief, to tell him of their arrival. The Chief then beat his royal drums, *emilango*, so that everyone would come to the palace. When all the men were present, he informed them that the Queen would soon arrive and there was no doubt that she was in need of her dogs. Toward evening, drums could be heard in the distance and it was not long before the procession of women could be seen. The Chief immediately went into his sleeping room to array himself in his royal garments. He then ordered his Headman to beat his drums—the noise at the palace was deafening.

The Queen was now approaching the palace, resplendent in her shining dress. She knelt before the Chief and greeted him.

Kasinge bwacha sugu, Osingire Rugaba, "Greetings great one, may you live long."

The Chief then greeted the Queen: *Bwacha*, "Welcome."

He then ordered the drummers to cease their beating so that he could speak with the Queen, and the great crowd of people at the palace quieted to hear his words.

"Your dogs arrived here safely, madam. On the first day I sent some of my men to hunt with them in the nearby jungle. They were very successful and many wild animals were killed. My chief messenger, Nkubitizi, had informed me of your warning and every man was told. But in the excitement of the second hunt, some of my men forgot the warning and ordered the dogs to attack more than once. Just as you predicted, the dogs have disappeared. For this we are all guilty and we ask your pardon."

"In that you have been truthful, sir, I cannot be angry. I came here in peace, not for war," replied the Queen. "But now I am greatly troubled. Our meat supply is exhausted. What shall I do without our dogs?"

The Chief then bowed his head so he could speak only with the Queen.

"Do you suppose there is some way for you to eat food that has been cultivated? Could you abolish that taboo?"

"We are in trouble indeed. We cannot return to our country without our dogs, and we know nothing of crop cultivation. The dogs you have lost; now you must find a solution for us."

The Chief pondered her words for some time. Then he stood before the crowd and announced:

"Listen all of you men and women who are newcomers here. After discussing matters with the Queen, I have come to the following decision. The Queen and her women cannot return to their country since we have lost their dogs. So now I shall give to each of the men one of the women. Each man is responsible for his woman. He must teach her how to

he Cossums aren't trying to save the world. st a little piece of it.

ester Davis is a friendly, dark- ittle boy whose smile can light entire room. But for most of x years, he hasn't had much to about.

ester lives in Laurel Creek, an lachian town of 200 people in nty with a per capita income 557 a year. Like most of the people of Laurel Creek, Lester in a three-room weatherboard e, along with his mother and r and nine brothers and sisters. have no well, and of course no e plumbing. So Lester's mother, ie, carries all the family water om the nearby creek.

Lester's father, Ray, used to work ie coal mines, but since the s "played out" he's been unem- ed. As Tressie admits, "It's aw- ard going. We never could get good start before." They still dn't have a "start" if it weren't he Cossum family.

Ed and Martha Cossum live in burban community of contem- ry homes. Looking out back you see one of those large, above-ground plastic swimming pools. And you can see the beginnings of a redwood deck around the pool, which Ed and his two children, Bill and Carol, are ding themselves.

Ed is a systems analyst. He nds most of his day thinking ut third generation computers. tunately, Ed and Martha also ık about this generation of chil- n living in Appalachia.

Through Save The Children eration, the Cossums are helping ter and his family. They contrib- $15 a month. Though it's not a of money, the Cossums could bably have done a lot of other gs with it.

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Mr. Davis already has a project mind. He plans to use the Cossums' money to buy and feed two cows, then sell the calves as they come along. As Mr. Davis says, "A man likes to find ways to take care of his own family."

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cultivate, for these women must learn to eat something besides meat. Now then, I shall have the Queen. My Headman shall have the Queen's Headwoman, and the rest of my men will take the remaining ladies."

And so it was that men and women came to live together. They began to change their eating habits. Since the dogs had been lost, the women refused to eat any meat from a wild animal. They chose to eat the *obwita* and *enumbu,* and learned to eat cow's meat and some fish. It was not long before the Queen's stomach became swollen, and many other women found themselves in the same condition. But ever since the women had left their own country, they felt like strangers in this new country. Even after they had children you could hear them say, *Omwana wa bandi,* "the child of another," or *Owabo bandi,* "I live in the country of another." And when a man and his woman were quarreling, you might hear the man yell, "Let me kill you, you dog." And the woman could be heard to cry, "But where shall I run?"

It also happened that illnesses,

Aniceti Kitereza, a man now seventy-four years old, lives on Ukerewe Island, which is located in the southeast portion of Lake Victoria, Tanzania. The home of Kitereza and his wife, Anna, is a lonely one. None of their four children lived beyond the age of two. According to the traditions of their people, the Kerebe, they are poor indeed, for there is no one to help them cultivate, and even more im-

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death, and evil doings started to increase after the women came to live with the men. For the women began to consult the *abafumu*, "medicine man," to obtain love making potions. Sometimes the *abafumu* would give them poisonous medicine that caused the men's stomachs to swell. And when the men would go to the *abafumu* to find out who had done this thing, they were told it was the women's doings. And so from those days until now, many women became *abalogi*, "sorcerers," looking for medicines and always talking witchcraft wherever they would meet.

This is how men came to live with women and how men came to consider them unusual people. You might hear a man in anger say to his wife. "You were brought here by the dogs, who is your relative here?" So to this day, when a woman is married, people say, *Owabo bandi*, "you go to the country of another"; and when children are born you hear, *Omwana wa bandi*, "the child of another." Thus, no woman will rule again; she will die without taming her own animals and all things she may acquire will not be her own.

---

portantly, there is no one to care for them in their old age.

Nonetheless, Anna continues to work in their rice, potato, and cassava *shamba*, and although Kitereza is badly crippled with rheumatism, he helps her when he is able. During his enforced hours at home, however, he is far from idle. In a part of the world where tradition has been slower to lose its foothold than in those areas of Africa more influenced by the West, this man has been preserving his peoples' customs in writing. Twenty-five years ago, he began collecting folk tales and proverbs, and writing stories that incorporate the ways and beliefs of the Kerebe.

His early education began at Kagunguli, a Catholic primary school on Ukerewe. After five years he was sent by the church to Bukoba, a port on the western shore of Lake Victoria. where he attended a seminary administered by White Fathers. His teachers were French, German, and Dutch, and for ten years (1909-19) he studied under their tutelage. Always fascinated by languages, he showed a proclivity for Latin, German, and Swahili. With the appear-

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ance of British administrators following the First World War, he started to teach himself English, using a German dictionary.

He returned to Ukerewe at the age of twenty-three to take a teaching position at the same primary school he had attended. However, his salary was so meager that he soon sought other employment. He clerked for an Italian merchant in Mwanza, the port closest to the mainland, until the outbreak of World War II when his employer returned to Italy.

Kitereza then obtained a position with Father Simard, a Canadian priest, at the Kagunguli mission. It was during the years 1939 to 1944 that he was first encouraged and stimulated to write. Kitereza and Simard collaborated in the collection of folk tales and proverbs. Simard also suggested that Kitereza begin to write down the customs of the Kerebe. Little encouragement was needed, as Kitereza was now old enough to have seen considerable change on Ukerewe, and he felt strongly that the earlier traditions should be preserved.

His first rendition was so dry and academic that he turned to the novel form. Simard felt the result was a "find," and promising to translate it into French, he took the novel with him on leave to Canada. However, when he returned to Ukerewe, he told Kitereza that he had not found time to do it. Before his next leave, he once again promised that he would translate the novel. But Simard never returned to Ukerewe; he died in 1952.

Fortunately, the novel had been typed, and there were two more copies. Kitereza's name was now familiar to many as a collector of Kerebe literature. Inevitably, many strangers came to his door either to talk with him or to review his material. One such person, after seeing the novel, indicated an interest in seeing it published. And so the second copy vanished. As Kitereza aptly puts it from his own experience: "We now have a proverb that says: 'When the Europeans came they treated us like monkeys,' which is to say, they took everything from us that they wanted."

The last copy of the novel was in the hands of another White Father in the area. He finally relinquished it this year when he felt convinced that a promise of publication would be fulfilled. Kitereza is now in the laborious process of translating 300 typewritten, single-spaced pages of Kikerebe into Swahili, and the East African Literature Bureau has decided to publish the novel.

"How Women Came to Live with Men" is an excerpt from the novel. It is a story told to the main characters, a young couple, in the same manner that folk tales and proverbs were related in Kerebe society. In the evening, when the family would gather around the fire, proverbs and folk tales were told with the specific intention of teaching the young, for each story had its moral. Sometimes the proverbs were used by the parents as a competitive device between children—who knows more? Or for variation, music was interpolated during the narration of some tales. Always, the specific intent was to instruct children in the mores and beliefs of their society. Unfortunately, this custom is quickly fading, one of the casualties of progress.

Thus, this short story is related to the young couple to tell them "how women came to live with men." Although Kitereza declares this excerpt to be mostly from his imagination, it is couched in what he knows—the island and his people's past. Everyday life is the pervading theme of the excerpt, as it is of the novel, and the reader is given a brief glimpse into aspects of earlier Kerebe culture: the relation of men to women, the importance of children, eating customs, the role of the Chief, and attitudes towards death and disease.

Kitereza's setting for this story has a historical basis. He describes the "men's country" as being overrun with wild animals that destroyed crops. Until a generation ago, portions of Ukerewe were covered with dense growth where wildlife abounded. Hunting was an important activity, and the accompaniment of musical instruments is borne out in oral tradition. In fact, hunting has proved to be a key in tracing the early role of music. Today, there are 70,000 people on Ukerewe and the island has been cleared of its dense growth for cultivation. Although most of the animals have been killed, the "taboo" of eating wild game remains, except for the varieties of antelope. Kitereza exercised his prerogative as an author in stating that cassava was a traditional staple—the staple was, in fact, millet. Cassava has become important only in the twentieth century.

The relationship of men to women is at the center of this short narrative. Although Kerebe society is patrilineal, oral tradition records a time when a few matrilineal clans were on the island. That a woman leaves "her country," which may be only five miles from home, when she marries is indeed true, even today. The husband is the head of the household: he owns everything. The woman's role is certainly a subservient one. Nonetheless, she wields considerable influence because of her capacity for work and her ability to bear children. The references to sorcery and witchcraft underline the "unusual" quality attributed to women, who are accused of sorcery more frequently than are men. Kitereza hastens to say, however, that one should never call a woman a dog (as recorded in this story), for a dog is truly the lowliest of God's creatures. One must treat a woman with respect—after all, she bears the children.

Completely unaffected by post-World War II influences, Kitereza does not write in the genre of most other contemporary African writers. He is not seeking identification; he fights no battles, voices no protest. His writing is simple, unsophisticated, objective. His goal is to preserve tradition before it is erased by time. His intended audience—the Kerebe.

Kitereza's writing and collections also provide another folkloristic source for writers in future creative endeavors. Furthermore, because he writes in the indigenous language, Kikerebe, his work will undoubtedly be of interest to African linguistic scholars. For Kikerebe has changed even more rapidly than the recorded customs. The language is no longer spoken except by the elders. Not only has Kitereza preserved an oral tradition for his own people, he has also provided the rest of the world with a valuable addition to the accumulating wealth of African folklore. Perhaps Kitereza's endeavors in traditional literature are best understood in his own words: "Words that are spoken fly with the wind, but words that are written live forever."

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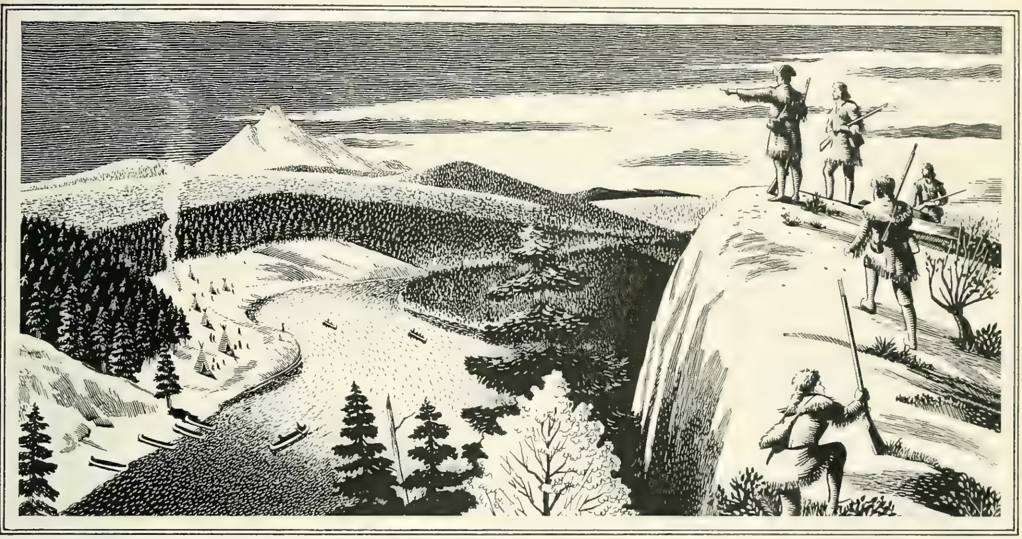

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The Island Earth

by Margaret Mead

In 1940 Edna St. Vincent Millay wrote a poem called "There Are No Islands, Any More," which moved those who were involved in World War II very deeply. The theme, that nowhere on this planet could man flee from man and be safe, that war and its aftermath reached to the most remote islands, tugged at the imagination of those of us who were living through the most widespread war in history, a war that culminated in the horrors of Hiroshima. People stopped talking about finding themselves an island where life could be lived out in peace with nature, and those who were fond of quoting added, from Donne, "No man is an island, entire of itself. . . ." Islands as a daydream of escape went out, and casual acquaintances stopped asking to be taken along on my field trips. When islands were mentioned, it was their vulnerabilities that were spoken of: population growth in Mauritius and Samoa; Japan's awareness of the need for population control; the devastating volcanic eruption in Bali that destroyed a third of the arable land; the unwillingness of Java's population to leave their crowded island for a less crowded one. The emphasis continued to be on the theme, "no place to go, no hiding place down here." Islands pointed out the interconnectedness of men on earth and their mutual vulnerability to each others' homicidal and genocidal aims.

The emergence of Indonesia as a new nation—the fifth largest in the world—was all the more striking because this is a nation made up of 80 million people living on 3,000 islands, and people raised their eyebrows when Indonesia tried to extend the limits of sovereignty to include the inland waterways of her watery empire. Buckminster Fuller designed a map—a diomaxion map—which showed the continents of the earth as an interconnected land mass. Islands were definitely out, a handicap in some way or other to full-scale continental living.

Then came NASA and the moon program, and finally the first breathtaking photographs of the earth from the moon. Mankind joined the astronauts in their willowy, eerie, unweighted walks on the moon and saw the earth in all its isolated diversity. Earth became an island in space. The earth seen from the moon was a whole in a new sense, no longer simulated by a globe, but seen whole. Scientist fathers conversing with their small sons found themselves confused because they were still earthbound looking toward the moon, while the children were on the moon looking back toward earth.

Besides these major transforming events—the sense of political and military vulnerability that grew up after World War II, and the specific change in perspective that has grown with the space program as the earth has become planet Earth—something else has been happening. Men everywhere are becoming conscious that this planet, like any small island, is interconnected in ways other than war and rumors of war. The spread of radioactive dust; the long journey of DDT from someone's rose garden to the shell-less eggs of unborn birds and the bones of unborn children; the new, resistant strains of venereal disease and malaria, which are robbing us of our recent conquest of these dangers; the knowledge that man's activities can alter the temperature of the earth, create storms of inestimable strength, pollute the oceans as well as the small lakes and streams that are dying throughout the civilized world: all have brought home to us that the earth is an island. Interconnected the peoples of the earth are—vulnerable to each other's weapons and no longer able to defend their frontiers and their children; vulnerable also to the acts of people half a world away, as they casually dump tanks of nuclear by-products into the sea depths, which no one has yet properly explored, or send clouds of pollution through the air. As those who love and protect the wilderness and try to save a part of it for man, and as those who see their main crop destroyed by the by-products of human intervention in agriculture or animal husbandry, so now the whole world is coming to realize the interconnectedness between the way men live and whether or not their children and their children's children will have a habitable world. Not war, but a plethora of man-made things—disposable, indestructible beer cans; too much industrial waste in the lakes and streams, from antibiotics designed to protect egg-laying fowls to pesticides designed to protect the orange crop—is threatening to strangle us, suffocate us, bury us in the debris and by-products of our technologically inventive and irresponsible age.

Continued on page 102

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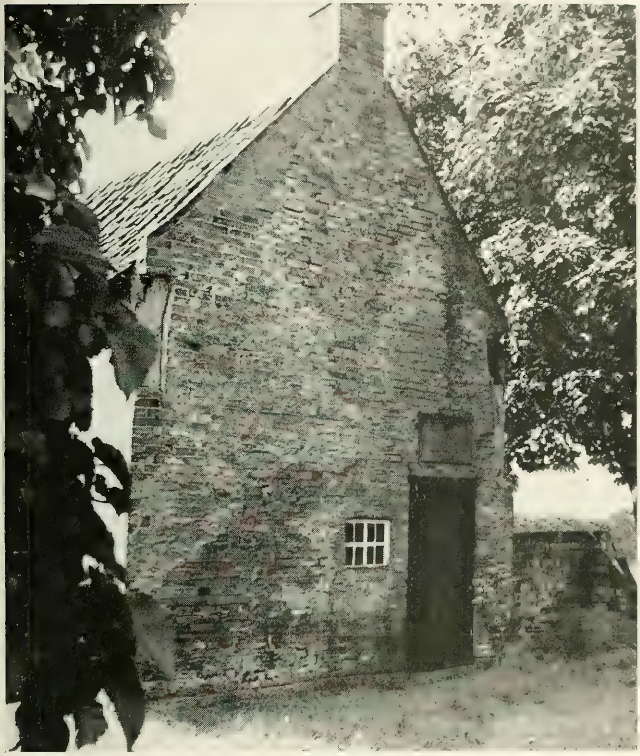

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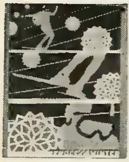
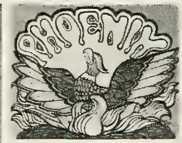
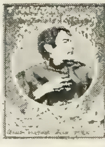


P238. ENDLESS WINTER. Ski bum paradise in blinding dayglo red, chartreuse, blue & white. 29" x 41". *Only* **1.98**



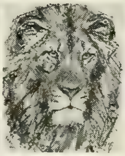
P239. PHOENIX. Rebirth of the legendary Phoenix; dayglo cerise, burnt orange, purple, green, chartreuse & black on blue back ground. 29" x 23". *Only* **1.98**



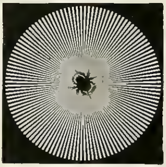
P294. TIMOTHY LEARY for GOVERNOR OF CALIFORNIA. Silkscreen dayglo greens, cerise, blue, brown. 20"x28". *Only* **1.98**

GIRLS SAY YES
to boys who say NO

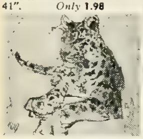
P246. BAEZ GIRLS. "Proceeds from the sale of this poster go to The Draft Resistance"; black & white. 29½"x42". *Only* **1.00**



P147. Hug: LION'S HEAD *On Canvas:* in brown tones and yellows. 22"x 28". *Only* **5.95**

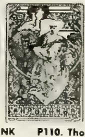


P963. ZONK. In brilliant, dayglo colors on black. 39½" square. *Only* **2.49**

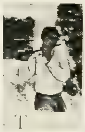


P146. Hug: LEOPARD. *On Canvas*- a leopard in repose, lithographed in brown tones and yellows. 28" x 22". *Only* **5.95**

P127. MARIE THREE. The famous Marie in a Recamier pose—clad in Saran Wrap; in full color. 42"x 29½". *Only* **1.98**

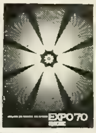


P117. PINK LADY. In dayglo pinks and burnt orange. 20¼" x 31¼" *Only* **1.98**

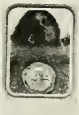


P110. Thoreau: ON INDIVIDUALITY. Painting by Hazard Durfee with greens predominating. 30" x 45". *Only* **3.95**

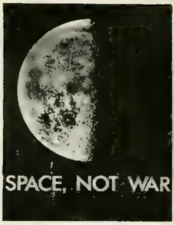
P876. MARIE. Photograph in full color— 29¼" x 52½" *Only* **1.98**



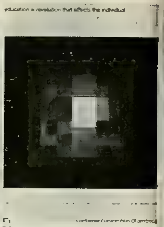
P676. OSAKA EXPO '70 POSTER. Chrysanthemum in bronze-gold with red center on black background. 29¼"x 42". *Special* **1.98**



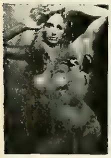
P111. Faulkner: "I BELIEVE . . . that man will not merely endure/he will prevail/ . . ." 30" x 45" *Only* **3.95**



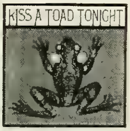
P215. SPACE, NOT WAR. Superbly detailed moon photo in black and white. 16" x 21". *Only* **1.00**


education is revelation that affects the individual
container corporation of america

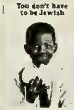
P109. Lessing: "EDUCATION IS REVELATION THAT AFFECTS THE INDIVIDUAL." Purples, reds, grays, yellow & white center. 30" x 45". *Only* **3.95**



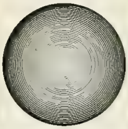
P962. MORE MARIE. In full color on coated stock. 29½" x 42½" *Only* **1.98**



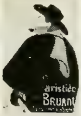
P775. KISS A TOAD TONIGHT. Toad in reds on olive green background. 25½" x 25½". *Special* **1.49**


You don't have to be Jewish
to love Levy's

P794. You don't have to be Jewish to love Levy's. The Levy's Rye Bread poster is now a full-fledged classic. Full Color; 30" x 45". *Only* **3.95**

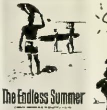


P677. TARGET. *HUGE* in blinding red, yellow, black and white. 40" x 40". *Special* **1.98**

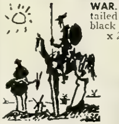


P570. Toulouse-Lautrec: ARISTIDE BRUANT. Collotype in black, green and a subdued orange on a cream background. 20"x 28". *Special* **1.00**

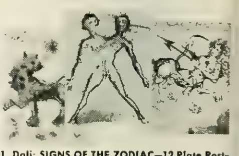
P880. BRIGITTE BARDOT. In Full Color—Bardot in necklace, golden hair, and water. 29½" x 42¼". *Only* **1.00**



P667. ENDLESS SUMMER. Iridescent hues of fuchsia, orange and mango with figures in black. 29¼" x 40". *Special* **1.98**

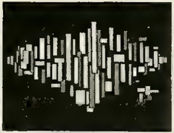


P737. Picasso: DON QUIXOTE. *On Artists' Canvas*—silkscreen in black on white canvas. 20" x 24". *Special* **2.98**

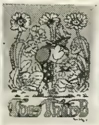


P301. Dali: SIGNS OF THE ZODIAC—12 Plate Portfolio. Reproduced in *eight* colors. Incredibly imaginative, each a masterpiece. Each 14" x 18". *Portfolio of 12, Only* **9.95**

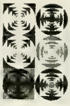
P187. GRETA. Painted lady motorcyclist athwart a Los Borrachos M.C. rod; full color. 42" x 29". *Only* **1.98**



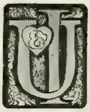
P129. SYNCOPATED RHYTHM. Color blocks in rhythmic pattern; dayglo greens, red, blue, orange, on black. 29" x 23". *Only* **1.98**



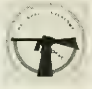
P130. TOM THUMB Dayglo greens, reds & yellows on a blue background. 21" x 27". *Special* **1.98**



P789. SIGNALS OP circles and squares in dayglo fuchsia, dayglo green and rust. 25" x 38". *Only* **1.00**

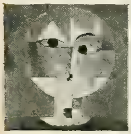


P240. U&I. Dayglo burntorange, rose, cerise, chartreuse on matte black. 23" x 29". *Only* **1.98**

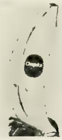


P242. WE SHALL OVERCOME. Matte black fist & rifle, black lettering, dayglo cerise & green circles on chartreuse. 28" square. *Only* **1.49**

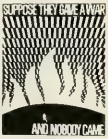
P793. WANDA EMBRY. In full, delicious color, life like! and life size! 12" x 63". *Only* **4.95**



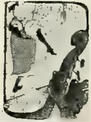
P665. Klee: SENECIO. Hues of red, pink, yellow, cream and burnt orange. 15¾" x 17". *Only* **2.98**



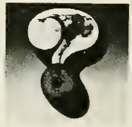
P666. CHIQUITA BANANA. In ripe banana yellow. 19" x a 48¾" banana high. *Special* **1.00**


SUPPOSE THEY GAVE A WAR
AND NOBODY CAME

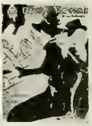
P788. SUPPOSE THEY GAVE A WAR—AND NOBODY CAME. Silkscreen in black and dayglo red. 25" x 38". *Special* **4.95**



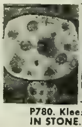
P572. Toulouse-Lautrec: JANE AVRIL. Collotype in shades of green, yellow, subdued orange and gray. 20" x 28" on heavy stock. *Special* **1.00**



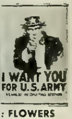
P177. "?" The world the dot of a question mark, with a mushroom cloud swirling above; in 4 colors. 23" x 29". *Only* **1.98**



P573. Toulouse-Lautrec: DIVAN JAPONAIS. Collotype in shades of green, gray-green, yellow and subdued orange. 20"x 28" on heavy stock. *Special* **1.00**

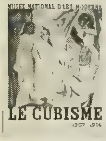


P780. Klee: FLOWERS IN STONE. Lithograph in orange, pale cream, green, blue, and rose. 18¾" x23½". *Pub. at $7.50. Now Only* **2.98**

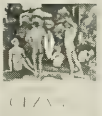


P883. I WANT YOU. In subdued red and shades of blue. 29½" x 39½". *Only* **1.98**

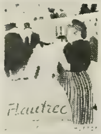
ART EXHIBITION POSTERS



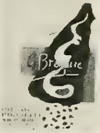
P249. PICASSO—LE CUBISME. 1953 Exhibition with famed "Demoiselles d'Avignon" in warm browns, ice-blue, ice-gray & blue, 20" x 28". *Only* **1.00**



P250. HOMMAGE A CEZANNE. 1954 Exhibition with Cezanne's "Bathers" in muted greens & browns. 20" x 28". *Only* **1.00**

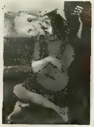


P251. LAUTREC—VILLE DE NICE. 1954 Exhibition of Lautrec graphics; yellow, beige, gray, blue. 20" x 28". *Only* **1.00**

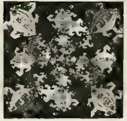


P252. BRAQUE GRAVEUR. 1953 Exhibition poster in yellow, black, blue-gray & brown. 20" x 28". *Only* **1.00**

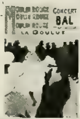
P286. Complete Set of 4 Posters. *Special* **3.88**



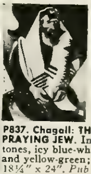
P835. Picasso: THE GUITARIST. Classic in blues with brown 18" x 26½". *Pub. at $7.50* *Only* **2.98**



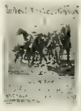
P112. FROGS. Dayglo cerise, orange, chartreuse, blue, green on matte black. 29"square. *Only* **1.98**



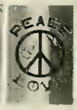
P571. Toulouse-Lautrec: MOULIN ROUGE. Collotype in shades of green, yellow, black and subdued orange. 20" x 28" on heavy stock. *Special* **1.00**



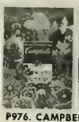
P837. Chagall: THE PRAYING JEW. In dark tones, icy blue-white, and yellow-green; 18¼" x 24". *Pub at $7.50.* *Only* **2.98**



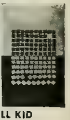
P878. JOIN THE CAVALRY. In subdued blues and browns. 29⅓" x 40¾". *Only* **1.98**



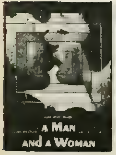
P960. PEACE/LOVE. Black with a day-glo rainbow background running from cerise through orange, yellow, green to blue. 23" x35" *Only* **1.98**



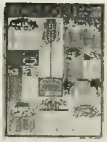
P976. CAMPBELL KID PSYCHEDELIA. Psychedelic foliage in a rainbow of bright, striking colors. 24" x 36". *Special* **1.98**



P790. OUT-OF-STEP. Blue and dayglo orange patterns out-of-step. 25" x 38". *Only* **1.00**

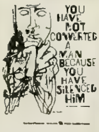

A MAN AND A WOMAN

P884. A MAN AND A WOMAN. In dayglo cerise, green, orange, red, on matte black background. 29" x 40½". *Only* **1.98**

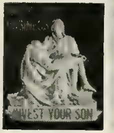


P175. CALORY GUIDE POSTER. 350 food and beverage items in several bright, attractive colors. 21" x 29". *Only* **1.98**

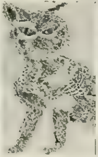
P871. Lorin Gillette: LOVE. Couple embracing against a background of sea and sand. 17¼" x 21½". *Only* **1.98**


YOU HAVE NOT CONVERTED A MAN BECAUSE YOU HAVE SILENCED HIM

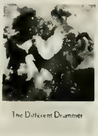
P858. Ben Shahn: YOU HAVE NOT CONVERTED A MAN BECAUSE YOU HAVE SILENCED HIM. Black & brown on white. 30"x 45". *Only* **3.95**



P276. WAR IS GOOD BUSINESS—INVEST YOUR SON. Lithograph in ice-blue, deep blue, and red lettering. 23" x 29". *Only* **4.95**



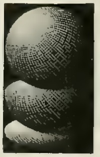
P115. CAT. In flaming dayglo green against dayglo cerise and orange background, 20¼" x 30" *Only* **1.98**



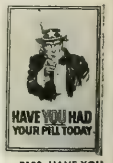
P193. THE DIFFERENT DRUMMER. Poster for the famous NYC clothing store après Rubens' Rape of the Sabine Women; reds, blues, browns. 22½" x 35". *Only* **1.98**

ATLANTA POP FESTIVAL

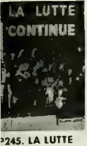
P233. LED ZEPPELIN— Atlanta Pop Festival. Dayglo red, orange & green on matte black. 21" x 30" *Only* **1.98**



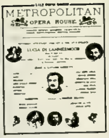
P114. SPHERES. Vivid dayglo red, orange, and green spheres on a matte black background. 19" x 31". *Only* **1.98**


HAVE YOU HAD YOUR PILL TODAY

P190. HAVE YOU HAD YOUR PILL TODAY. Uncle Sam on the population explosion; black on white. 23" x 29". *Only* **1.98**



P245. LA LUTTE CONTINUE. French student poster in dayglo red on white. 26" x 41". *Only* **1.49**



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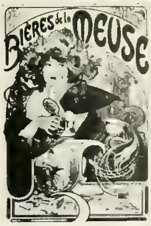
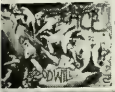
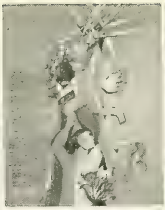


P716. Mucha: BIERES DE LA MEUSE. Muted tones of purple, yellow-gold, red, cream. A huge 34¼" x 53". *Special* **2.98**

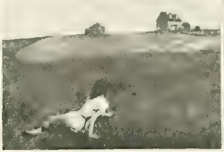


P305. PEACE-GOODWILL. Doré in *Dayglo* silkscreened in blinding cerise, orange and green. 27" x 21". *Only* **1.98**



P157. PEACE ON EARTH. A young man's questions, with him since childhood, go unanswered, when he falls before an enemy bullet—shades of red & brown. 19" x 24". *Only* **1.98**

P282 SIX FOOT JOINT A mighty six foot trip in shades of yellow and gray 24" x 6 feet. *Only* **1.98**



P840. Andrew Wyeth. CHRISTINA'S WORLD Magnificent collotype from the Museum of Modern Art: harvest colors on fine art stock. 28½" x 40". *Only* **7.49**

P280. WOODSTOCK—WE ARE ONE. Superb photo montage of the Woodstock Festival in monochrome with green lettering. 23" x 35". *Only* **1.00**

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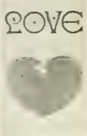
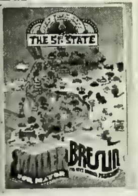
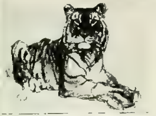


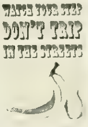
LOVE (with a Band-aid). In lavender & broken orange heart; 22" x 35".



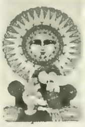
P195. MAILER for MAYOR OF NYC. Full color Mailer-Breslin poster—map of NYC as the 51st STATE. 24" x 36½". *Special* **1.98**



P148. Hug: TIGER. *On canvas*—lithographed in brown tones and yellows 28"x 22" *Only* **5 95**

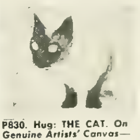


P987. DON'T TRIP. Warning, over a handsomely rendered banana peel; shades of green & banana yellow. 22" x 35". *Special* **1.00**

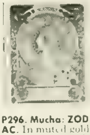


P159. LE SOLEIL—Tarot Card XVIIII. "The Sun," 19th card of arcana, mustard green & blue. 24¼" x 37¼". *Special* **1.00**

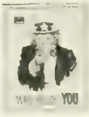
P220 INNOCENCE IS INVULNERABLE. John and Yoko in dayglo chartreuse, purple, orange and black. 19¼" x 26" *Only* **1.98**



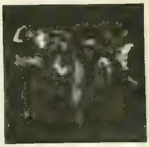
P830. Hug: THE CAT. *On Genuine Artists' Canvas*—delightful Siamese cat in tones of brown, yellow and cream. 29¼" x 22¼". *Special* **5.95**



P296. Mucha: ZODIAC. In muted golds, creams, reds, zodiac circlet in pale blues & greens. 22" x 28". *Only* **1.49**



P285. WHO NEEDS YOU. Mad Magazine poster in red, white & blue. 23" x 29". *Only* **1.98**



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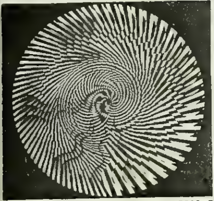
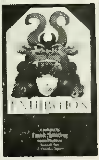


P217. HYPNO-MANDALA. Huge hypnotic swirl in dayglo red, yellow, blue, on a purple background. 20¼" square. *Only* **1.00**



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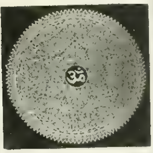

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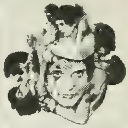

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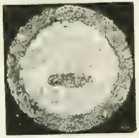
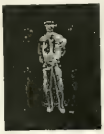


P237. NO SMOKING PLEASE . . "By the Way, every Cigarette shortens Your Life by 13 Minutes"; dayglo-brite lemon yellow, cerise, green, blue, orange on matte black. 21¼" square *Only* **1 98**



P879 Picasso TOREADOR. White line drawing on matte black background 26" x 35". *Only* **1 49**

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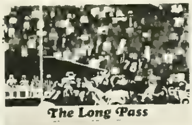

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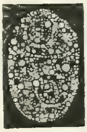

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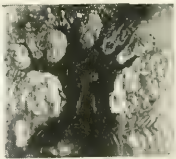

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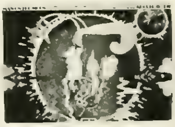

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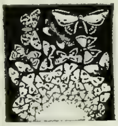
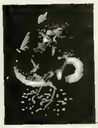
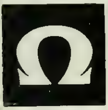


P219. CREATION OF BUTTERFLIES. Flashing dayglo hues of yellow, orange, cerise, blue and green on matte black. 23⅝" x 25⅝". *Only* **1.98**

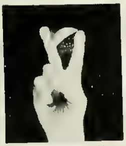
P121. MANDALA OF THE MAGNIFICENT. Silkscreened in dayglo cerise with blue, purple & gold. 34" square. *Only* **2.98**



P118. DRAGON. Vivid dayglo colors on matte black. 21" x 29". *Only* **1.98**



P243. OMEGA. Resistance symbol in glaring dayglo orange on matte black. 30" square. *Only* **1.49**



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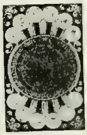

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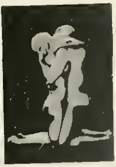

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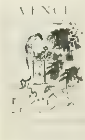

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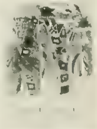

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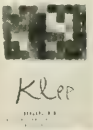

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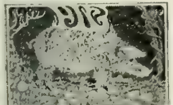

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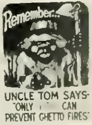

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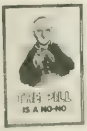

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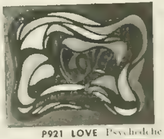
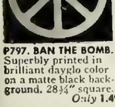


P921 LOVE Psychedelic swirls of matte tones, subdued reds, blue, purple, yellow, green, black 42[illegible] **3 98**

P236 "THE EXPERIENCED". [illegible] Hendrix in the [illegible] dayglo purple, cerise, green, blue, burnt orange & matte black. 21" x 30[illegible]. *Only* **1.98**



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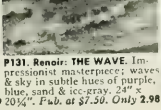
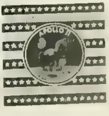


P131. Renoir: THE WAVE. Impressionist masterpiece; waves & sky in subtle hues of purple, blue, sand & ice-gray. 24" x 20¼". *Pub. at $7.50. Only* **2.98**



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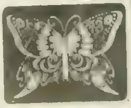

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FORMS IN THE SKY

When the causes of form are understood, astronomers can use analogy to penetrate the structure of stars and planets

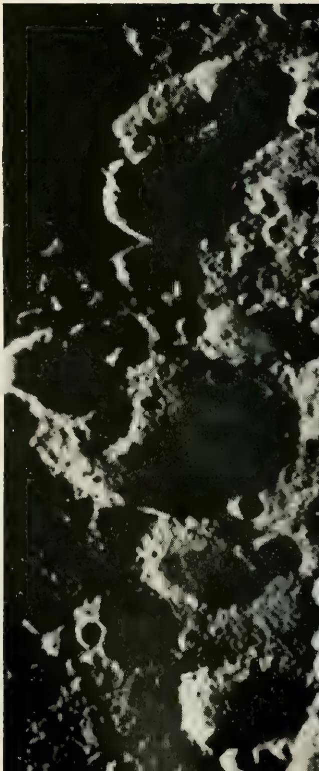
by Charles A. Whitney

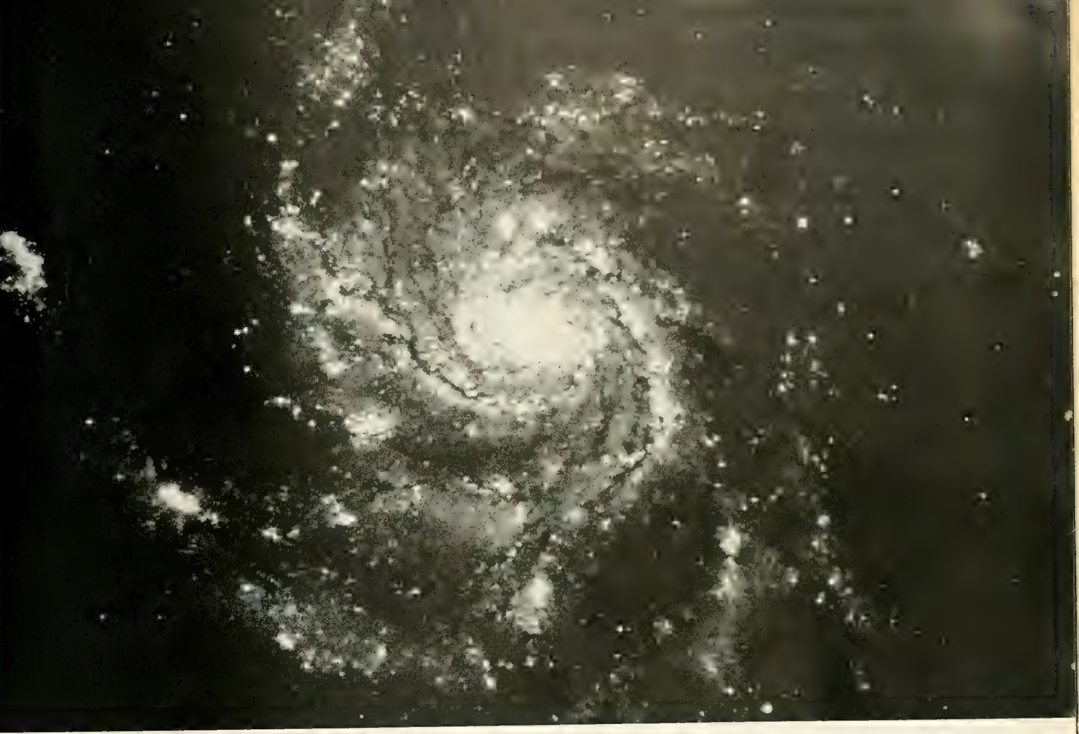
I am frequently asked how astronomers discover so much about the sky from photographs and measurements of radiation. A full answer would be complex and would necessarily have to take into account the large number of techniques that can be combined in an attack on a given problem of astronomy. But generally stated, in the standard approach to such problems, mathematical analysis and intuitive synthesis are employed in an alternating pattern of induction and deduction.

This approach is well known and is taught in all scientific institutions. But there is another approach, argument by analogy. It has a lengthy history of scientific application—stretching back to the time of the Greeks—but it is not quite as respectable as analysis and synthesis. It often works, but it cannot be trusted blindly. The scientist gambles when he employs this technique to make inferences and extrapolation; he can be misled unless his analogies are based on fundamental similarities of the objects being compared.

Most analogies used in astronomy are based on similarity of physical form, either of the internal structure or of the apparent shape and pattern of objects in space. Often these shapes are only dimly seen. The astronomer cannot manipulate or tear apart his specimens, so he regards observed form as crucially important. Analogies permit the astronomer, in his mind's eye, to penetrate the structure of stars and planets, to sense the forces that bind the wispy clouds of interstellar gas, and to scan the history of the solar system.

But inferences based on physical form and the technique of analogy can be trusted only when the various *causes* of form are distinguished. (I use the word in the limited sense of "immediate" or "proximate" cause.) Astronomers classify the causes of form in two ways: On the one hand, they speak of historical versus nonhistorical form, and on the other, statistical versus geometrical. These categories are not mutually exclusive; the form an object takes, for instance, can be governed by processes that are both historical and statistical. Let me specify the distinctions among these causes and then illustrate them.





Statistical form is typified by the globular star cluster in Hercules, upper left, a celestial swarm of "gnats" held in symmetric disarray by gravity. Another example is the spiral galaxy in Ursa Major, above, in which a pattern emerges from individual motions. The lunar surface, left, is a clear example of historical form: action in the past irreversibly changed what we see in the present.

Types of Formative Process

Historical: Some processes clearly distinguish the past from the future: the burning of a match or the rusting of an iron nail or the descent of a meteor. These are historical, or irreversible, processes and each, in its own way, implies the ultimate heat death of the universe. To alter the metaphor, these are the processes that put the tip on the "arrow of time."

Nonhistorical: Some events are not tagged with a truly forward or backward direction or chronology. These occurrences are nonhistorical, and they do not look peculiar when viewed in reverse. The bouncing of a lively ball on a hard surface is one example, because it simply seems to be repeating itself (if we do not watch too long, of course; if we do, the bouncing is seen to decrease in height). Suppose, as another example, we make a movie of a ball thrown into the air. The flight of the ball will be nearly frictionless, and if we show the movie backward, the flight will look perfectly natural. Such processes are also called reversible, to distinguish them from the irreversible processes in which friction works a rapid decay of motion.

In our observable world, friction is unavoidable— there is no perpetual motion machine. Therefore every process is, to some degree, irreversible. Only in the world of atoms do we believe truly reversible events can occur—atomic collisions or emissions of light are considered to be precisely reversible. The irreversibility of large-scale events is merely a reflection of the low probability of certain types of events that involve a large number of atoms or stars. If, for example, all the camels in the desert were to be placed on one hill, we would later expect to find them dispersed. We would be quite surprised if, unguided, they all reappeared later at the same oasis. The larger the number of camels, the greater would be our surprise.

The motion of the earth about the sun is virtually frictionless. There is not sufficient gas in space to impede our planet by a perceptible amount, so the orbital motion is termed reversible. If we made a movie of the solar system and recorded the circlings of all the planets and their satellites, a visitor from another star would not know whether we were showing him the movie reversed or forward. He could not develop a sense of history from such a film.

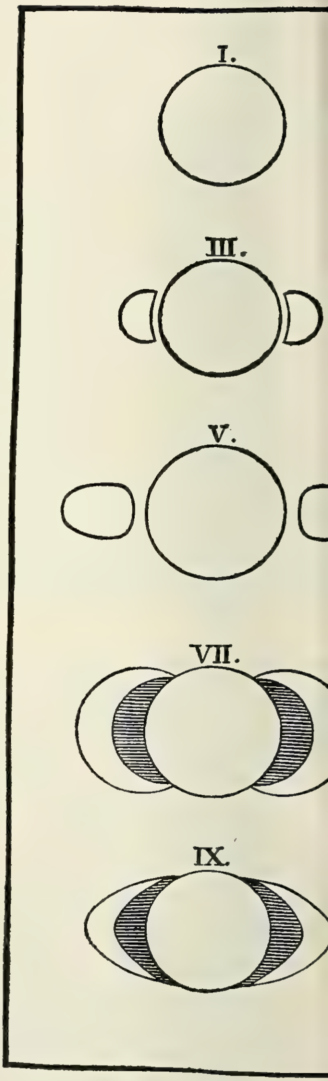
But the distinction between historical and nonhistorical processes can be difficult to specify. In the case of the bouncing ball, the impression we obtain depends on the precision of our measurements and on the patience with which we await the decay of the bouncing. More important than this uncertainty in defining reversibility is the fact that the nature of the process can change with the passage of time.

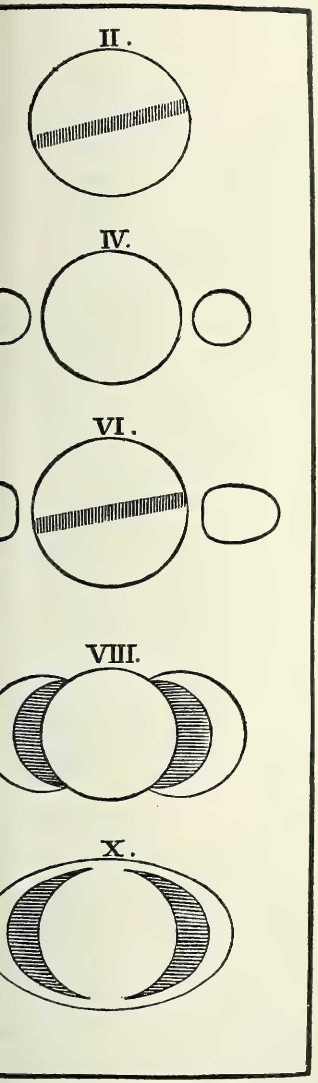
Again, the solar system provides the best example because the present flat arrangement of the planets compels us to believe that the solar system must have behaved quite differently in the distant past. Chance alone cannot explain the present coplanar alignment of the planets, nor are there any forces now at work that could throw the planets into such a precise arrangement.

In slightly different terms, the solar system is now in a nonhistorical state; it appears "constant" to us. It does not distinguish the past from the future. Yet if we seek to explain its entry into its present condition, we must assume the action of historical processes in the past. (In much the same way, our reaction to seeing a ball roll across the floor is to imagine that someone introduced a historical element by *pushing* the ball.) For this reason, Laplace developed his celebrated hypothesis, according to which the planets condensed from the envelope of a swirling nebula.

Statistical: A swarm of gnats or a cluster of stars is roughly spherical because its members pursue a random pattern of orbits about a vacant center of collective attraction. The distant view of either object reveals only the smoothed-out sum of the orbits—a spherical smudge.

If we say that each orbital flight of a gnat or a star is an event, we might characterize the smudge as





Early drawings of Saturn, above, show the earlike appendages detected by the first users of telescopes. Argument by analogy, later confirmed by improved telescopes, held that the appendages had to be the now familiar rings, as in photograph at right.

the result of apparent equilibrium among a multitude of scattered and random events.

Geometrical: Some forms result from a static equilibrium—an equilibrium of tension between forces rather than events. For example, the shape of a salt crystal or of a snowflake reflects the configuration of molecules nestling quietly, and almost statically, together. Similarly, the shape of a planet or of a drop of rain water results from the symmetrizing forces of gravity and surface tension.

Astronomical Forms

The illustrations in this article show the variety of astronomical forms.

The globular cluster in Hercules (*page 26*) is probably the purest example of statistical form. In addition, its internal processes are reversible because its stars, although crowded in the photograph, are actually so far apart they never collide. They interact only by the gentle hands of gravity.

The spiral galaxy in Ursa Major (*page 27*) is also an example of statistical form. It is composed of stars and gas, and the orbits are arranged in a flattened pattern, so the galaxy appears to swirl about its center of attraction.

The precise origin of the "arms" of the spiral pattern is still debated. Although the arms are certainly the result of gravity, it is not clear whether they are the result of reversible or irreversible processes. In one view, they are the residue of clumps of stars, stretched out by the rotational motion of the galaxy—not unlike the streaming of cream in a cup of spinning coffee. In another view, they represent "standing waves," or gravitationally produced condensations of stars, resembling clusters of automobiles at busy intersections.

The pattern of craters on the lunar surface (*page 27*) is obviously a case of historical form. On the other hand, the flattened shape of Jupiter (*page 30*) is a geometrical form resulting from reversible processes. It is produced by the centrifugal force of rotation in competition with the centripetal force of gravity.

Also deserving comment are the planetary nebulae, so named for their appearance in a modest telescope. A nebula is shown on page 31. These nebulae are celestial neon signs —their tenuous gas is excited to glow

by a hot star. Their shape is determined by a statistical process: the outward spreading and depletion of light from the central star. All the energy emitted by this type of nebula originates in the atmosphere of a single, very hot, but quite faint, star. In many random collisions of light photons with gas molecules, the nebula converts the star light to radiation of a different color.

Saturn's Rings and the Use of Analogy

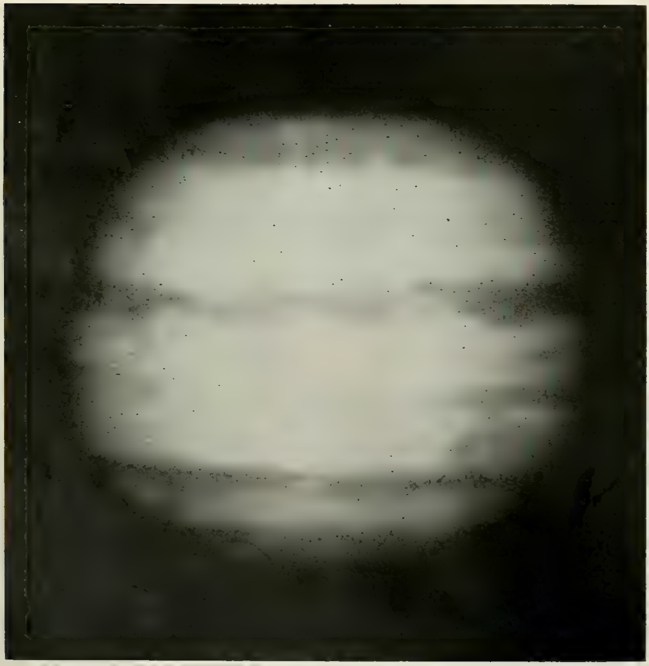
One of the finest early examples of the power of argument by analogy and inference from form is Christian Huygens' discovery of the rings of Saturn. In 1609 Galileo detected lobes or earlike appendages attached to the disk of Saturn (*page 29*). As the planet moved around the sun, these lobes narrowed and briefly disappeared, but they remained unexplained for almost 50 years until Huygens re-examined Saturn. He immediately announced that these appendages were rings around the planet.

Huygens' argument was the following. The moons of Saturn were known to revolve about that planet with periods between several days and many weeks, and their motion obeyed quite accurately the known laws of planetary motion. As Saturn, its moons, and its "appendages" are all part of the same system, and probably had a common origin, Huygens argued that they must all obey the same law of rotation. The appendages must therefore rotate in only a few hours. But, and this is the critical step in the formal argument, the appendages do not appear to vary visually in a period of hours, so they must possess a form that would appear unchanged during rotation. Only a ring fits these criteria, Huygens reasoned. No doubt, Huygens' acuity is partly explained by his greatly improved telescope, but his insight and his sight had been sharpened by a theoretical argument employing an analogous model. His achievement is a fine example of a theory calling forth a new definition of the "facts."

I have emphasized the sources of form because these sources must also be understood before analogy can be applied to scientific analysis. Let me conclude by commenting on the role of analogy in the development of science.

When true genius is lacking, scientists progress by applying old ideas to new problems. When a genius appears on the scene, he produces a revolution by breaking out of the old modes of thought and by applying new ideas to old problems. Essential to both the plodder and the revolutionary is the transfer of ideas from one context to another, and analogy provides a powerful tool for effecting this transfer. Mathematical analysis, itself, should be viewed as a form of analogous reasoning, because the behavior of solutions of equations is compared to the observed behavior of physical objects.

The scientist uses analogies to stimulate his intuition. He is guided by form, and he recognizes that one prerequisite of good science is the ability to distinguish fundamental and fruitful analogies from those that are accidental and purely superficial.



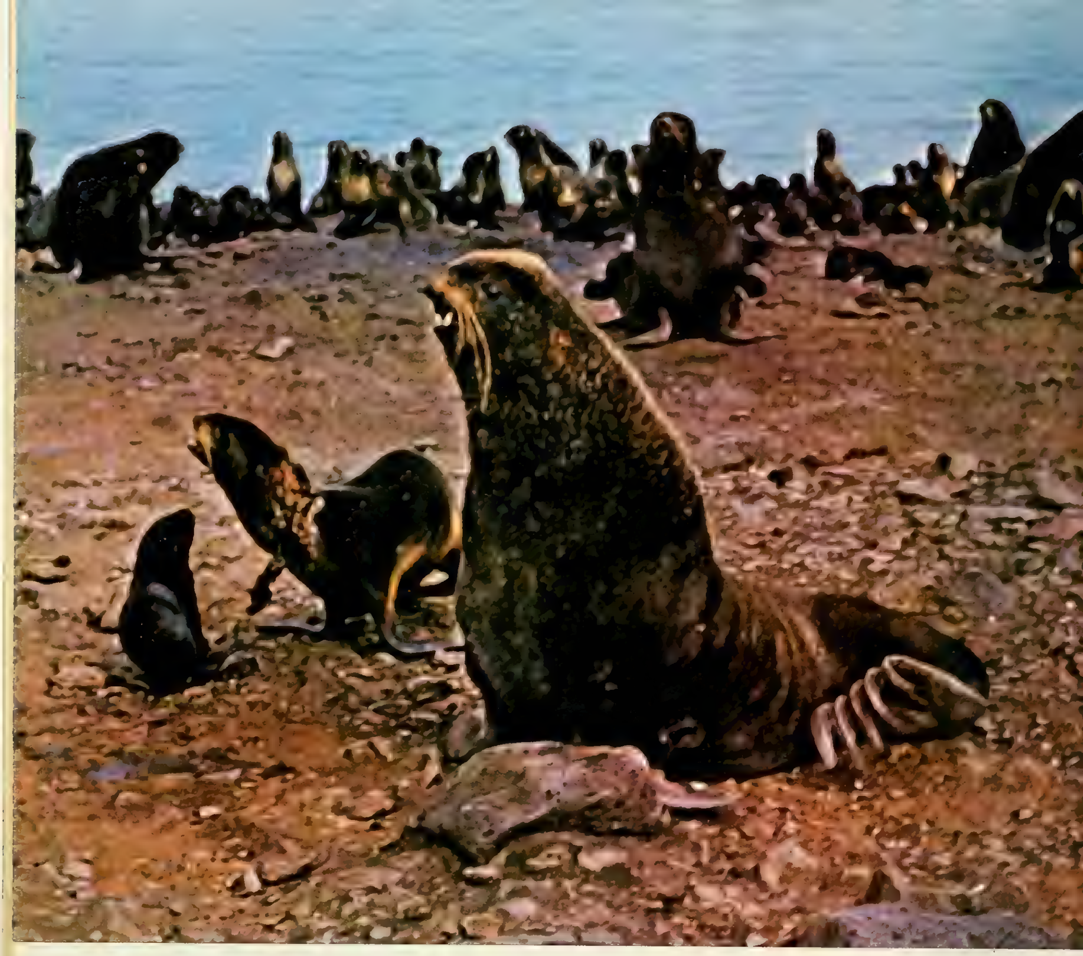
Jupiter's slightly flattened shape, left, is an example of geometrical form. The shape represents equilibrium between the centrifugal force of rapid rotation and the pulling force of gravity; it says nothing about the past. The planetary nebula in Aquarius, right, is statistical form, the result of apparent equilibrium among many random collisions of photons from a central star with molecules in an expanding envelope of gas. The glow from the collisions shows the outward spreading and depletion of light.

In summer, St. Paul Island, one of the Pribilof Islands in the Bering Sea, is the breeding ground for two-thirds of the world's northern fur seals. The federally run island is the home of 400 Aleuts, who live in federally owned housing and are employed by the U. S. Bureau of Commercial Fisheries to annually kill forty to eighty thousand young male seals whose pelts are sold to furriers. Mature males and their harem females are not harvested, and their breeding continues without interruption. Females give birth on the island and mate again while suckling their newborn pups. In October and November, seals leave the island for their winter ranges farther south in the Pacific.

SEAL HAREMS
N THE PRIBILOFS

Richard K. Mathews

doesn't take long for a visitor to
St. Paul village in Alaska's Pribi-
Islands to realize that the northern
seal, *Callorhinus ursinus*, is the
ic fact of life. Pulling up to the
llow-water dock, the sputter of the
outboard is instantly replaced by the deep, resonant cattle yard sound of nearby seal rookeries. And as soon as the gasoline fumes clear, the acrid, musky scent of massed seals pervades the air. Walking up to the village, the islander who welcomed you ashore points out the most imposing structures: In the long shed on the left, he explains, seal skins are processed and stored, and in the big, gloomy corrugated metal building in the distance, the carcasses are ground into mink food. The vehicle rumbling out over the tundra is not a dump truck, but a carcass truck, the one into which he himself will be pitching bodies when the sealing season opens in late



Above, a mature bull (foreground) will often attack females that stray from his harem, inflicting wounds and driving them back into his territory. Copulation, right, takes place five days after the cows have given birth. The polygamous bull is able to mate with several females in a single day.

BERING SEA
ALASKA
PRIBILOF ISLANDS
St. Paul
ALEUTIAN ISLANDS

June. He is a baseball fan, like most residents of St. Paul, and on coming to the playing field, he ends your guided tour with an invitation to watch his team trounce the "Blubberers" later in the afternoon.

From the playing field the neat white houses of the village proper are visible; they are so uniform and laid out in such monotonous rows that one immediately suspects that the government is somehow involved. Later queries reveal this to be the case; not only did the federal government plan them, it also built them and owns them, as it owns just about everything else on the island, and all because of the seals, also government owned and the sole reason for its presence here.

The place to get acquainted with people in St. Paul is the little community-owned tavern past the post office. Cans of Country Club malt liquor, which sometimes seems to have replaced seal meat as the staple of the islanders' diet, are passed around, and introductions made to Porfiry Stepetin, Maxim Emanoff, Nectary Galaktionoff, and others who tell you they work as "clubbers," "pod cutters," "stickers," "rippers," and at other ominous-sounding jobs; they are all government employees, all sealers. The town's economy is the seal, and what little money doesn't come from regular wages earned in its harvest comes from a few small sideline enterprises, such as that of Alexander Melovidov who sells dried seal penises at 50¢ each to an aphrodisiac maker and exporter in Brooklyn, New York.

Not only the incomes of the islanders. but their Russian names and that they are living on the Pribilofs at all is strictly contingent upon the seal. In 1786 when the Russians discovered the uninhabited islands they coerced Russified Aleuts to settle there and do their sealing for them. One result is that today, St. Paul village, although it has only 400-odd inhabitants, is the largest community of the vanishing race left on earth: a town of dark, often handsome men and women who still speak their native language and pray to God in it when Father Lestenkof holds services in his yellow Russian Orthodox church.

St. Paul is the summer home of two-thirds of the world's population of northern fur seals and the only land on which most of these animals ever come ashore. Of these 1,200,000 seals, each year 40,000 to 80,000 are killed for their pelts, which the U.S. Bureau of Commercial Fisheries auctions off to furriers for nearly $100 each. This harvest consists entirely of immature males, mostly three- and four-year-olds, and since these animals do not enter the breeding rookeries of adult seals, rounding them up does not interfere with the activities of the latter. So on the one hand, the island is the scene of the seal harvest, performed by Aleuts wielding five-foot ash clubs, and on the other, it provides a spectacle of massed, nearly unmolested wildlife on the nearby breeding ground.

There are eight sharply defined sections of St. Paul's shoreline where all the breeding seals congregate. One of them, Zapadni, is a rocky crescent of beach facing a little bay. It is about six miles from St. Paul. The landscape along the way is typical of the island as a whole: gently rolling hills and broad valleys, all lava-built and quite young. The early summer weather is also typical of the area: a fine, ceaseless drizzle with fogbanks pressing in from the Bering Sea. The low summer temperatures (48° F. is average) and the nearly continuous overcast (22 clear days a year, mostly in winter) are doubtless attractive to the well-insulated fur seals, but these weather conditions combine to prevent the growth of trees—or any other woody plants bigger than pencil-thin willows—on the tundra surface. By June 25 the bleakness is softened by lush grasses interspersed with various saxifrages and bright dwarf buttercups, whole acres of deep-blue lupines stretch away up the gentle slopes, and the road to Zapadni is bordered with neat yellow rows of colonizing Arctic poppies.

Zapadni rookery is about two miles long and extends from thirty to over three hundred feet in from the nearly tideless water of English Bay. The Bureau of Commercial Fisheries census takers have constructed several wooden counting platforms, which extend into the midst of the rookery. These are excellent vantage points.

Far up the shoreline one sees a swath of indistinct hazy motion, of shifting, wriggling forms emerging from the fog. Closer to the platforms the swath resolves itself into the hulking, triangular shapes of gray-brown bulls and smaller mouse-colored females. More than a dozen of these females cluster around each bull on the shoreline, and each cluster borders directly on a neighboring one. But twenty or thirty feet back from shore there are only bulls, spaced evenly over the rocky terrain—some stretched out asleep, others turning their heads from side to side as they broadcast a deep loud roar at the human intruder, others cooling themselves by rhythmically waving their hind flippers back and forth. How many seals are visible? The census takers must be remarkable men, for there are so many young, old, female, and male seals doing so much shov-

The harem bull guards his cows zealously against any intruder. Here, a male directs his deep roar toward an approaching photographer.

ing, writhing, charging, nursing, copulating, blatting, snorting, fighting, and hissing in so small an area that the amateur is forced to put his estimate at anywhere from three thousand to three hundred thousand.

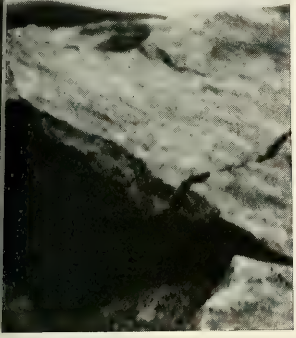
The scene becomes less bewildering if one focuses on a single nearby individual—such as the bull about twenty feet away. He is surrounded by twenty-three females and eight pups, one of which is dead and lies rotting in a crevice. The surrounding rocks, smoothed by past generations, are smeared by the blood, amniotic fluid, and feces of the present one. On the highest rock the bull naps on his belly. He is not large as bulls go—perhaps four hundred pounds—but he weighs four or five times more than any of his cows. His dense coat is a deep brown, except for the grizzled mane that reaches from forehead to midback. His expressive brown eyes have been watering, and his cheeks are streaked parallel to his long drooping whiskers. His partly open mouth reveals four long white canine teeth.

He does not really sleep. Every minute or two he shifts position slightly and raises his head to look around. Now and then he rhythmically waves one hind flipper up and down a few times. He is cooling himself, for although it is still drizzling and not over 55 degrees, he is insulated by one of the densest furs known; the only effective way he can lose excess body heat is by exposing his naked and highly vascular flippers to moving air.

A sudden noise, unheard by the human observer, startles the bull. He hunches himself up into an erect position and emits a clicking sound. He focuses on a neighbor approaching what is apparently the boundary line between their contiguous domains. Immediately, as his pups and females flee in all directions, he rushes toward the other bull. The latter turns to face him, and the two charge to within two feet of each other. With heads pressed downward, backs arched, and manes bristling they lunge toward each other's front flippers. Their forward motion ceases abruptly just short of contact, and instead of bites they exchange a breathy sequence of chug, chug, chug sounds, like a stalling one-cylinder gas motor. Now they raise their heads and look aslant at each other, necks zigzagging to and fro as though feinting or attempting to throw each other off balance. Then both suddenly break off the ritual and return toward the centers of their territories.

When the bull near the platform charged, some of his cows moved to what seemed to be another section of his territorial boundary; now, clicking and growling, he begins to circle them. The cows greet his patrol by craning their heads upward and trying to grab his muzzle or neck in their teeth. The bull herds them deeper into his territory by shoving and nipping until he comes to one that has apparently strayed beyond his boundary. He rushes after her, clamps his jaws on her shoulders and half carries, half hurls her back. The marks his canines make are visible on her fur.

Having twice circled his territorial bounds, the bull again drapes his bulk over his customary resting rock. He breathes heavily and fans both rear flippers vigorously this time—it was a two-flipper exertion. As he renews his restless vigil, his cows snap and hiss at each other.



Breeding bull fur seals are as active at night as in the daytime, and if this once in Zapadni typifies those studied on nearby rookeries, he has reached the third week of the six- to eight-week period that he will guard his territory. From the time he first establishes it until he abandons it in late July or early August, he will eat nothing nor will he leave his post for more than a total of a few hours, if at all; during all this time he will exert himself strongly in fighting, patrolling, and copulating. As we shall see, his ability to stay on shore so long, which depends in turn on his ability to store large amounts of fat, is essential to the complex and rigid social organization of his species. The bulls are thought to spend most of the winter in the rich waters off the Aleutians and in the Gulf of Alaska where they feed heavily on squid, herring, capelin, and other small fish. When they return to haul out on the Pribilofs, beginning in late April, the vast masses of their blubbery bodies ripple like jelly, the skin is stretched too tight for wrinkles, and exceptionally heavy fat deposits pad their shoulders. In short, they are very well prepared for the long fast to come.

When they migrate north, the bulls not only locate the small, foggy Pribilofs, but proceed to the precise two or three hundred square feet of rock they occupied the previous year and where, in most cases, they were born. As they approach the rookeries they linger just offshore for a few days, resting and grooming themselves. They are fairly sociable at this time and are often seen in small groups. But by the end of May, a dramatic change has occurred. Every bull that has arrived has landed and has either established or is attempting to establish a territory. Hostility and violence prevail.

Unless a bull is the first arrival at a particular section of rookery, he will find that bulls already there have each claimed very large areas, most likely including his territory of the year before. As the would-be occupant swims in to land, he is warned off by the loud, prolonged roars of those present. He is not persistent in his first attempts, however, and retreats. Staying close by, he may haul up on an offshore rock and scratch himself with his hind flippers (fur seals have a flea all their own), or rest. But in an hour or two he is back, and every time he challenges the occupants, he does so with greater aggressiveness. After four or five days and twenty or thirty attempts, the bull usually succeeds.

He approaches the shore stealthily—lying low in the water, avoiding noise and splashing—and then hauls out at a spot where the terrain is particularly advantageous to his advance. Despite his stealth, he is quickly noticed by resident bulls who immediately set up a chorus of threatening roars, a reaction that, incidentally, is the only example of coordinated social activity among bulls. But this time the challenger lowers his head and plunges blindly toward his former territory. Every bull through whose domain he passes attempts to attack him, but he lunges on until blocked or held. A dramatic battle then ensues in which the combatants bite viciously at each other, shoving and roaring. Within seconds, however, fighting assumes a formal pattern, with two bulls facing each other. Chest to chest they shove, feint with head and neck, and bite in rapid succession. When each has a jaw grip on the other, both suddenly freeze for a long interval to catch their breath. If the invader gets free of one defender, he soon finds himself battling another in the next territory, and sometimes, when he is at the corner of three different territories, he will be confronted by three opponents at once.

These combats seldom result in death, but foreflippers, a favorite target, are often torn. Also, skin elsewhere may be ripped, canine teeth broken, eyes gouged. The black rocks of the rookery are now crimson in places, and a human observer can identify many individual bulls by the shapes of the pink gashes in their deep brown fur.

If the challenger is successful he will have to be content with a small piece of ground at first, in some cases hardly enough to turn around on. He must meet repeated threats and attacks by the bull or bulls from whom he appropriated his territory, and at whose expense he now tries to extend his boundaries toward an average size of about 350 square feet. After a week or so, however, he is "accepted" by his neighbors; that is, he can now defend his territory mostly by threats rather than actual fighting. His boundaries have stabilized considerably, and are precisely demarcated, although whether by scent or behavior is not certain.

Territorial aggressiveness varies considerably from individual to individual. An extreme case is described by Karl Kenyon, an authority on marine mammals of Alaska: "Bull #8 frequently and energetically patrolled his territory, challenged neighboring bulls to bluffing bouts, and often provoked them to biting skirmishes that filled the air with bits of fur. He expanded his territory boundaries to a diameter approximately 20 by 25 meters and on several occasions pursued idle bulls and harem intruders for nearly 30 meters beyond these boundaries. When, during the course of spraying operations [to mark bulls with paint for identification], an attempt was made to drive a truck into his territory, he charged it vigorously and succeeded in blocking it from his area."

After a bull establishes his territory he usually guards it as did the Zapadni bull described earlier—mainly with vocal threats, frequent patrolling, and ritual lunging. The Zapadni bull had twenty-three females clustered in his territory on June 25. Already other members of his harem had undoubtedly returned to feed at sea, but the mass arrival of more females that annually occurs in the next ten days would probably assure him of additional recruits. Although twenty-three is a little above the Pribilof average some bulls have maintained harems in which a hundred females have been counted.

Indeed, there is no other mammal species in which polygamy is more extreme. Nor is there any in which the male's weight is so large in proportion to the female's weight. The initial arrival of the females at the rookeries gives a clue as to how these two extremes are related and the bearing that they apparently have on male territoriality.

The female, like the bull, has a strong homing instinct that causes her to return and bear her young at the same rookery year after year. In choosing a spot to land she is governed by this instinct, not by preference for the bull who happens to rule there. On seeing her, this bull rushes down to cut off her escape. Then, being so much larger, he easily moves her toward the center of his territory; usually by pushing, sometimes by picking her up bodily in his jaws. He then patrols around her, emitting a rasping chirp that apparently informs her of territorial boundaries that must not be transgressed. Determined females can, and frequently do, escape from a given bull. Generally, however, a female's passivity, coupled with the male's aggressive possessiveness, results in her settling down with the first harem she meets—unless it becomes so crowded that the bull can no longer effectively dominate the situation. Because females land on the sea side of the rookeries, the shore harems fill up before inland ones form. It is perhaps significant that aggressive bulls sometimes defend large territories that, for reasons of location or terrain, are not well supplied with females. Indeed it appears that bulls in general do not select territories on the basis of sexual potential any more than females select landing sites on the basis of their male occupants.

Except for the one or two days when she is in heat, the female's reaction to the harem bull is marked by frequent hissing, nipping, and attempts at avoidance. The bull for his part is extremely possessive toward his cows and sometimes quite violent with them. On occasion two bulls will clamp their jaws onto a disputed female at the same time and engage in a tug-of-war that could have lethal results. In addition, the females show hostility among themselves. Indeed, after observing a seal rookery, where all is contention, sex, and property, one is prompted to the unscientific reflection that humans—although they ravage each other and their environment—don't live so nastily after all.

The females in the Zapadni bull's harem had produced eight pups by June 25: wide-eyed, jet-black little creatures resembling Labrador pups, except for the flippers with which they stumbled awkwardly over the rocks. In all probability none of their mothers were even at the rookery ten days before, and just as probably, some were already pregnant again. This remarkable telescoping of reproductive events results in the females landing, giving birth, copulating, and nursing—all within an average of only six days. Furthermore, the timing is such that females migrate northward from as far afield as the coasts of Japan and California, yet give birth on an average of only twenty-one hours after hauling ashore. Evidently they do not make major navigational errors, which would delay their arrival. Nor do they arrive too soon. There is no evidence that they congregate around the Pribilofs, awaiting the right mo-

ment to come ashore (as salmon linger in an estuary before proceeding upriver to their spawning grounds).

Neither the internal clock nor the compass that makes the female seal's feat possible is understood, but we can speculate on their evolutionary advantages to the species. Birth, the first reproductive task accomplished after landing, is concentrated into that period of late June and early July when Pribilof temperatures are approaching their maximum. If birth occurred earlier, chances of survival would be severely limited because the pups are not adequately insulated against freezing temperatures. If, on the other hand, birth occurred much later, the pups would lack enough time to develop and acquire adult pelage before weaning and winter forced them out to sea.

The first females arrive about June 15—just about the time that territories have become fixed and the chaotic violence of the bulls has shaded into the ritualized stability that would seem important to successful mating and pup survival. Every year in which studies have been made, the peak date of female arrivals has been July 5 or 6. This is just about the midpoint between the beginning of territorial stability and territorial abandonment by the bulls. In the timing and duration of this period, social factors may be closely linked with climatic ones. On land, seals show obvious signs of discomfort whenever the temperature goes above 55 degrees, and the bulls are not adapted to remaining ashore for long periods in August when temperatures frequently climb above this.

Polygamy combined with territorialism is a marked trait in other species of Otariidae, such as the southern fur seal and the sea lion, and indeed of many aquatic carnivorous mammals. Yet the northern fur seal has carried it to an extreme. The evolutionary "logic" here is not at all evident. However, it is a fact that the harem bull does impregnate a large percentage of his cows, so in this respect the system is at least reasonably efficient. The maintenance of polygamous territories probably has an important selective effect upon the seals. Many sexually mature bulls on the islands do not maintain territories; those that do have perforce demonstrated their physical and behavioral fitness.

The harem female copulates with the bull usually on the fifth day after giving birth. Then, and only then, the antagonism and fear she normally shows toward her mate disappears. Bulls inspect their harems frequently for the bright red vulvar swelling and the receptivity that characterize an estrous female. Then there is a series of mutually stimulating interchanges of nose rubbing and muzzling. The copulation that follows is often preceded by much shifting and struggling to overcome the mechanical problems of body shape, unequal size, and uneven terrain. Actual union lasts five to ten minutes. A harem bull, although famished and exhausted, is able to mate with numerous females in a single day—an important ability because estrous periods of the cows are brief and occur in many at the same time.

The occurrence of copulation just five days after parturition relates closely to two specialized features of the female's reproductive physiology. Her uterus is bicornuate; consequently, while one horn develops a fetus, the other lies dormant. The active horn is of course traumatized by birth, but the other is in a state of reproductive readiness. The second adaptation is delayed implantation: the fertilized egg goes through the first divisions, then lies dormant four to five months. All other pinnipeds (except possibly the walrus) and also a number of land mammals display the same phenomenon, but few pinnipeds, if any, have evolved reproductive cycles so dependent on it. Delayed development of the embryo allows the female fur seal to mate at the only time the harem bulls are breeding, in June and July, and yet bear her young just a year later at the only time climatic circumstances are optimal.

Females stay ashore an average of eight days, the longest stay of their yearly cycle, and return to the sea on the day after mating. Their pups are growing rapidly, and to nourish them the females themselves must eat. The presence of a million and a half seals on the islands depletes the supply of food in the normally rich adjacent waters, and the females range widely, at least as far as Tigalda Island, 200 miles southeast of the Pribilofs. Such trips take time—about a week for the first one, an average of nine days for subsequent ones—and the pups go foodless during each absence. That they not only survive but grow rapidly is possible because seal milk is extraordinarily rich, containing 46 percent fat (compared to about 3.5 percent for cows and humans); also, the pups have relatively enormous stomachs, which take up most of the body cavity and serve as storage tanks of up to one gallon capacity. After prolonged nursing, a young pup is so weighted and bloated that it can hardly walk.

The temporarily deserted pups go entirely untended, for the harem bull ignores them so completely that he will trample right over them if they are in his path, while unrelated females are either indifferent or mildly hostile. Evolution has endowed the pup with a marked precocity, however, and it has an 85 percent chance of living to go to sea. Even before the pup is completely outside the womb its eyes are open; it blats, moves about, shakes the amniotic fluid off its short black fur, and nurses—all within the first few minutes of life.

During the first day or two—but

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not later—the mother is solicitous toward her pup. She will hiss and nip at females or other pups that approach too closely, and if a man or a charging bull heads her way she will pick up the pup by the scruff of its neck and hustle it off to safety. During this period, too, she nurses and sniffs it frequently, and lies with it against her; she is literally "getting to know it," a crucial process if she is to recognize it later on.

When she returns from the sea, her homing instinct guides her to the section of rookery where her pup was born. It may have wandered considerably, especially in late summer and fall, but as experiments have shown, its own homing instinct is already sufficiently developed to bring it back to the natal spot. Several hundred other pups may be in the vicinity, however, and the mother must determine which is hers. On landing, she emits repeated sheeplike blats, high-pitched enough to be audible above the general din of the rookery. At this signal all hungry pups in the area converge on her. One after another she sniffs the muzzles they point up at her. One after another they are dismissed with a low hiss until, recognizing her own, she stops, shakes her head, and snorts briefly. Then she settles down, allowing her pup to nurse. Tired by her long sea journey, she usually goes to sleep almost immediately, and the pup may blat or even nip to wake her when she somnolently rolls over, concealing her teats. Several long and copious feedings occur during the two days that the female usually spends ahore after each foraging trip.

Fur seal pups are very gregarious, and since their parents are either absent or uninterested, the young form into loose, structureless pods, generally congregating in areas of the rookery where they are least disturbed by the rampages of the bulls. Pods are small when the pups are young, but number in the hundreds by mid-August—massed black phalanxes that wander and frolic, often on the green slopes quite far inland from the rookeries. By September the pods are breaking up, but already the pups have developed the basic motor skills and behavior patterns of later life: patterns "practiced" in the course of numerous nipping bouts, sex play, wrestling matches, and simulated charges during which they often become hopelessly scrambled in their own flippers before closing in on other pups or on driftwood.

Swimming will soon be the pups' main means of locomotion, but the adult fur seals play no part in the development of this or any other skill. Actually, the young can swim from birth if an exceptionally heavy wash of surf or a fall into the drink demands, but they show no interest in the water until they are two or three weeks old. By then, small pods of pups wandering widely about the rookeries will inevitably reach the shoreline. Here a pup will wade cautiously out into a shallow tidal pool or other protected spot, and then, after many retreats and much shaking off of water, it will take its first, jerky, dog-paddling strokes. It may submerge and revolve slowly around as it takes a first look at the underwater world that will soon supply all its sustenance. By August 1 when the first-born Pribilof pups are, at most, six weeks old, their curiously erect, high-floating forms can be seen splashing about in the kelp as much as fifty feet from shore.

At this time the situation at the rookeries is changing dramatically. Nearly all of the prime breeding females have been impregnated again and the attendant social structure

Each year, from early spring to late autumn, 1,200,000 northern fur seals inhabit St. Paul Island, gathering in eight rookeries along the shore. Zapadni rookery is shown at right.

is rapidly disintegrating. By late July it is evident that the bulls' territorial instincts are weakening—as indeed are the bulls themselves. Female-corralling patrols and male boundary-confrontations are becoming less and less frequent, while the boundaries themselves are increasingly fluid. Intruding bulls from outside the rookeries are still attacked, but with such diminished vigor that now they often hold their ground; and the cows that wander from one territory to the next often go unmolested. One by one the harem bulls, in such splendid shape two months before, are hauling their emaciated, dehydrated, exhausted, scarred, filthy bodies off the rookeries. For no outwardly apparent reason, one will suddenly make for the shoreline, slide into the water, and swim a few dozen yards out. Surfacing, he will roll over repeatedly, rubbing every bit of his body the front flippers can reach, scrubbing off an accumulation that turns the surrounding water brown. If another bull approaches, the first may circle and dive with him, so reduced is his aggressiveness. Later he will haul up on shore a little distance from the rookery for a prolonged sleep, and after this he will begin to feed again.

By October the first seals are leaving the Pribilofs, and by mid-November the vast majority have departed. The pups are weaned now. They are covered with a new, dense coat of silvery fur, the result of the October molt; and they are padded with stored fat, which will tide some of them over until they develop sufficient skill to support themselves at sea. A number will starve during the crucial months ahead, and others will fall victim to killer whales, sharks, oil slicks, and other hazards.

It is hard to conceive of any large animal more local in its special orientation than the fur seal on land, for a bull's territory, a female's particular rookery area, a pup's place of birth are very specific loci indeed. On the high seas, however, fur seals travel farther and roam more widely than any other mammals except whales. Adult females and immature seals of both sexes follow two basic migration routes. An important percentage travel south along the coast of Asia, where by December they are concentrated in the waters off Hokkaido and Honshu, Japan. Most, however, follow the American coast and during midwinter are found in largest numbers off Washington, Oregon, and California. These migration patterns are not narrow, strictly defined paths, for the seals are never massed together when using them; and while most females and immatures do follow these broad routes, scattered individuals have been reported at widely separate points all over the North Pacific. Although they travel alone or in very small groups, pelagic research has demonstrated that most of the seals in a given area are of the same age and sex. During the winter, fur seals spend most of their time in the open ocean, especially in the zone from ten to ninety miles offshore, but concentrations of food, such as the spawning spring herring of southeastern Alaskan inlets, occasionally attract them quite close to land.

In March and April the Pribilof fur seals begin heading north again, back toward the rookeries that hold such implacable sway over their individual lives and racial evolution. Three months later the black volcanic rocks will be repolished and the air filled once more with musk and roaring. A new generation will be born into the bondage of the islands.

THE STATE OF THE SPECIES

A NATURAL HISTORY SPECIAL SUPPLEMENT JANUARY, 1970

THE STATE OF MAN TODAY IS ONE OF ENORMOUS EXPANSION, RAPID EVOLUTION, AND EARTHWIDE IMPACT. SOME 300 GENERATIONS HAVE PASSED SINCE MAN BEGAN A NEW LIFE, TILLING THE EARTH AND SETTLING IN VILLAGES. NOW, WITHIN A SINGLE GENERATION, MAN WILL BECOME AN URBAN SPECIES, WITH OVER HALF OF THE SIX BILLION PERSONS IN A.D. 2000 LIVING IN HIVELIKE CITIES. THUS MAY END THE 35,000-YEAR SPAN OF *HOMO SAPIENS* AND BEGIN THE ERA OF *HOMO CONVIVENS*, A NEW COMMUNAL SPECIES THAT WOULD CONTROL ITS REPRODUCTION AND MANAGE ITS ECOSYSTEM–THE BIOSPHERE.

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The Origin of Man

by C. Loring Brace
University of Michigan

More than a century ago when Darwin published *On the Origin of Species,* it was authoritatively assumed by those who had not read the book that he was chiefly concerned with the origin of man. He actually mentioned the word *man* only once in the epoch-making work, and then in a cryptic sentence on the last page. But such is the strength of popular assumption that the title has been consistently misquoted. The popular press still refers to his book as *The Origin of the Species,* and *the* species is assumed to be man. This example typifies man's timeless fascination with himself, as well as his propensity for repeating misinformation about himself—a universal quality that may have been best summed up by the acerbic Ambrose Bierce early in the twentieth century when he defined man as "an animal so lost in rapturous contemplation of what he thinks he is as to overlook what he indubitably ought to be."

But what, then, is man? What was he in the past, and what has allowed him to survive to the present? If these questions are answered, we can then contemplate, perhaps with alarm, the basis for what is to come.

Central to any definition of man, and the key to his evolutionary success, is a phenomenon not immediately visible when specimens of the creature are scrutinized. This phenomenon is what the anthropologist calls culture. It includes not only the high points of art, music, and literature, but also all those things that result from the cumulative efforts of other people and previous generations. Tools, the traditions regulating their use, vital information, and language itself—all are included in the concept culture. Man is not just an animal that possesses culture, but an animal that cannot survive without it. Men could not exist if each had to discover anew the control of fire, the manufacture of clothing and shelter, the sources of edible sustenance, and the guidelines for workable interpersonal relationships, to say nothing of the mechanics, electronics, chemistry, and physics on which human life depends today. These elements of culture are a cumulative continuation of simpler counterparts in the past.

In the beginning our ancestors, like other animals, must have been faced with the problem of surviving without the aid of culture. So much of culture is perishable or intangible that there is no way to determine when culture as a cumulative phenomenon began. Nonperishable cultural elements have an antiquity of about two million years in Africa. The cultural tradition of which they are a part continues without break, expanding to occupy the tropical and temperate parts of the Old World around 800,000 years ago, and ultimately developing into all the cultures in the world today.

From this we postulate an African origin for all mankind. The existence of crude stone tools in Africa a million and a half to two million years ago allows us to suppose the existence of culture at that time. Our guess suggests that the possessor of this culture could not have survived without it; therefore, he deserves the designation *man*—however primitive and crude he might have been.

We further postulate that culture existed a long time before the initial appearance of recognizable stone tools. This is speculation, but not idle speculation, because we could not otherwise account for the transformation of ape to man. Although small in quantity, supporting evidence exists in the form of skeletal material. Fossilized remains, including skulls, jaws, teeth, and a few other skeletal pieces have been found in association with the oldest known stone tools both in Olduvai Gorge in East Africa and in the Transvaal of South Africa. Since the discovery of these fossils in 1924, argument has continued over their status —ape? man? human ancestor? extinct side line? Brain size was within the range of that for the large modern anthropoid apes, but these early hominids walked erect on two feet as does modern man. Molar teeth were of gorilloid size, but the canines did not project beyond the level of the other teeth.

Despite continuing arguments over whether the balance of traits was on the human or simian side, it is apparent that the survival of these early hominids depended on a distinctly non-apelike adaptation. Bipedal locomotion did not enable hominids to escape predators by rapid flight. Neither could these hominids seriously threaten to bite a potential predator. Contrast this with such modern ground-dwelling primates as baboons and gorillas where the enlarged canine teeth of the males represent formidable defense weapons. We can guess that these early hominids depended for survival on something not visible in their anatomy, and our guess is that they used hand-held tools.

Possibly they defended themselves with the crude hunks of worked stone found at the sites where their skeletal remains have been discovered, but more likely they relied on pointed sticks. To use a rock as a defensive weapon requires close contact with the attacking creature, while the defender probably preferred to face his tormentor from the far end of a pointed stick. Not only is the pointed stick a simple and effective weapon—devisable with a minimum of manufacturing effort—but it can also double as a digging tool. Edible roots and bulbs are a substantial part of the diet of baboons that live today in the savanna, an environment typical of the areas inhabited by the earliest hominids. The addition of a simple digging stick of the kind used by the surviving hunting and gathering human groups—and probably by the early hominids—could easily double the baboons' food supply.

The huge, worn molars of the early hominids indicate that they relied on gritty, uncooked vegetables for subsistence. Unlike any other primates, their canine teeth are functionally indistinguishable from their small incisors. Assuming that the remote hominid ancestor had enlarged canine teeth like all other primates, then the creatures associated with the stone tools in East and South Africa two million years ago belonged to a line in which the selective pressures needed to maintain large canines had been suspended for a long time. Cultural means of defense must have existed long before the earliest stone tools.

Within the last three years jaws and teeth have been found in southwestern Ethiopia that are so like the Olduvai and Transvaal finds that they must be related. Their antiquity, however, extends back nearly four million years, and no stone tools are associated with them. The canine teeth in the fragmentary remains are not enlarged, leaving us to infer that defensive weapons must have been used some four million years ago—two million years before the earliest stone tools existed.

Reliance on hand-held weapons for defense (and perhaps also for food getting) did not automatically convert apes into men, but it altered the forces of selection so that evolution in the human direction was a consequence. For one thing, occupation with tool wielding reduced the locomotor role of hands. Legs and feet, as a result of natural selection, assumed the entire burden of locomotion. Tools usurped the defensive role of canine teeth, and, with an accumulation of mutations, these teeth were reduced. The vast majority of mutations interfere with the development of the structures that depend on their control, but usually these "deleterious mutations" are eliminated by selection. When selection is reduced or suspended—as when tools reduced the defensive role of teeth—the reductive mutations simply accumulate in the ongoing gene pool of the population. The structure controlled by the genes—the canine teeth, for example—eventually fails to achieve the full development once characteristic of the remote ancestral population.

Early in hominid development, when defensive weapons were not well developed, those charged with the task of defense, the males, must have been substantially more rugged than those less concerned with defensive activities, the females. Among terrestrial primates where a culture with weapons plays no defensive role, males tend to be much larger and stronger than females. Baboons, gorillas, and other ground-dwelling primates are good examples. Fossil fragments hint that this must have been the case for the earliest hominids as well. The difference in robustness of specimens from the early levels of Olduvai Gorge, the Transvaal, and now from Omo in southwest Ethiopia has led some scholars to suggest that two different species of hominid—one small and slender, the other large and robust—shared the same habitat. However, now that we can demonstrate a time span of nearly three million years for the early hominids, it makes better ecological and evolutionary sense to explain the differences in size as sexual dimorphism—male-female difference—in a single species of early hominid.

The taxonomy of these earliest hominids continues to be debated. Genera such as *Australopithecus, Paranthropus, Zinjanthropus, Homo,* and others have been suggested, and even more species tentatively recognized. Whatever the taxonomic designation, these early hominids, except for their reliance on learned behavior and on hand-held tools for defense and food getting, lived more like apes than humans.

The evidence from Olduvai Gorge in East Africa shows that crude stone tools were added to the limited cultural repertoire toward the end of this long early hominid phase—a period I prefer to call the australopithecine stage. These tools belong to the incipient part of a tradition of butchering large animals in the Middle Pleistocene. At the end of the Lower Pleistocene, however, they occur mainly with the fossilized remains of immature animals. We can guess that this records the beginning of the adaptive shift that was largely responsible for the development of *Homo sapiens,* a shift related to the development of hunting as a major subsistence activity.

In the Middle Pleistocene, somewhat less than a million years ago, man emerges as a major predator. This adaptation is unique among the primates, and it is not surprising that many of the physical, behavioral, and physiological characteristics that distinguish man from his closest animal relatives are related to this adaptation. While we cannot make direct behavioral or physiological tests on fossils, we can make inferences based on their anatomy, on their apparent ecological adaptation, and on conditions observable in their modern descendants.

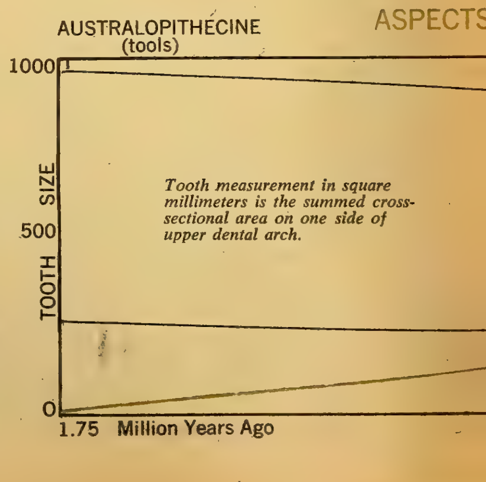
Anthropologists generally agree that the men of the Middle Pleistocene are properly classified as *Homo erectus.* The first specimen to be discovered was classified in the genus *Pithecanthropus* at the end of the nineteenth century. While we no longer accept this generic designation, pithecanthropine remains a convenient, nontechnical term for Middle Pleistocene hominids.

Brain size was twice that of the preceding australopithecines and two-thirds that of the average modern man. With the absence of a specialized predatory physique, natural selection probably encouraged the evolution of intelligence. While brain size had increased, the size of the molar teeth had reduced, although they were still quite large by modern standards. This reduction may have been related to the shift from a rough vegetable diet to one with a large proportion of meat. Meat, needing only to be reduced to swallowable pieces, requires far less mastication than starches, which begin the process of conversion to simple sugars by mixing with salivary enzymes through extensive chewing.

Evidence, although fragmentary, also suggests that bipedal locomotion in its modern form was perfected at this time, the Middle Pleistocene. While man's mode of locomotion may not be speedy, it requires an expenditure of relatively little energy. To this day, primitive hunters employ the technique of trotting persistently on the trail of an herbivore until it is brought to bay, often many days later.

Several correlates of this hunting life are suggested. Man, reflecting his primate heritage, is relatively night-blind and must, therefore, confine his hunting activities to the daytime. A tropical mammal (and physiologically man is still a tropical mammal) pursuing strenuous activities in broad daylight is faced with the problem of dissipating metabolically generated heat. The hairless human skin, richly endowed with sweat glands, is unique among terrestrial mammals of much less than elephantine size, and I suggest that this developed under the selective pressures of regular big game hunting early in the pithecanthropine stage.

The elimination of the hairy coat by natural selection left the skin exposed to the potentially damaging effect of the ultraviolet component of tropical sunlight. The obvious response was the development of the protective pigment melanin.



Tooth measurement in square millimeters is the summed cross-sectional area on one side of upper dental arch.

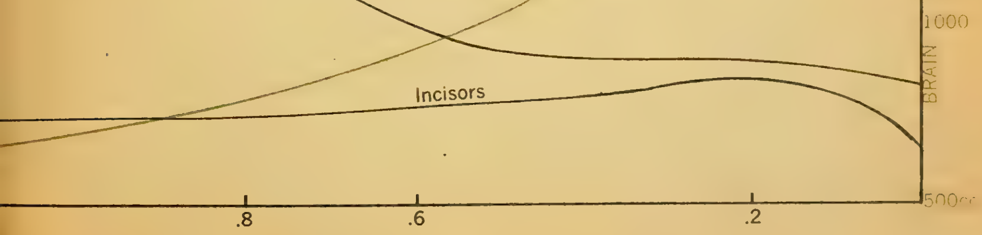
Consequently the Middle Pleistocene ancestors of all modern men were probably what in America today is called black.

The conversion of this being into what is technically known as *Homo sapiens* requires only the further expansion of the brain from the pithecanthropine average of 1,000 cubic centimeters (actually well within the range of modern variation) to the average today of 1,400 cc. Fragmentary fossil evidence suggests that this transition had taken place by the beginning of the Upper Pleistocene, about 120,000 years ago. Men at that time—referred to as Neanderthals—still had an archaic appearance. In general these early representatives of *Homo sapiens* were more muscular and robust than their modern descendants—particularly the males. Jaws and teeth were large, especially the front teeth, which, from their wear patterns, evidently served as all-purpose tools.

Since the first appearance of *Homo sapiens* in his Neanderthal form, human evolution has been characterized by a series of reductions. Whenever human ingenuity made life easier, there was a relaxation of the forces of selection, and these reductions followed. More effective hunting techniques lessened the burden on the hunter's physique, and an eventual reduction in muscularity was the result. Manipulating tools lessened the stress on the anterior teeth, and the consequent reduction of these and their supporting bony architecture converted the Neanderthal face into modern form. In parts of the world where manipulative technology is a late phenomenon, such as aboriginal Australia, faces and teeth have remained large. Where clothing was developed for survival in northern climes, the significance of protective skin pigment was lessened, and the consequent reduction produced the phenomenon that is euphemistically called white.

The only thing that has not been reduced is the number of human beings. We cannot even guess at the population density of the australopithecines. Throughout the Middle Pleistocene, the archeological record suggests a fairly constant population for the hunting pithecanthropines. Evidently the population increased dramatically with the Neanderthal form of *Homo sapiens*. The diversification of food resources and the increase in cultural complexity that accompanied the first appearance of modern *Homo sapiens* just under 35,000 years ago also signaled another sharp jump in population. This set the stage for the tremendous population growth made possible by the development of agriculture after the end of the Pleistocene 10,000 years ago.

Thus did *Homo sapiens* emerge—a manifestation of ecological imbalance, literally shaped by the consequences of his own impact upon the world. His fate, too, will be shaped by his future impact on the world—the result of his numbers and his actions. Malthus sounded the alarm nearly two centuries ago, but few listened to his warning. One who did was Ambrose Bierce, who added to his definition of man that "his chief occupation is extermination of other animals and his own species, which, however, multiplies with such insistent rapidity as to infest the whole habitable earth. . . ."



THE PROLIFERATION OF THE SPECIES

The ebb and flow of populations of man—or any other species—can be calculated using a brief formula:

Population + Births − Deaths = Future Population.

If the present size of population is known, *if* the birthrate is known, and *if* the rate of death is known, then simple calculations should give the future size of a population. Unfortunately, these *ifs* are rarely known and never constant.

Whether it is the legions of Herod trying to account for every child of Bethlehem, or a modern government attempting to count each of its citizens, no census is complete. The United States census, some critics argue, may underenumerate poverty and itinerant groups by as much as 10 percent. In less developed countries the error for the whole population may be much greater. The actual size of any large population is never known, and one of the crucial parts of demography is the estimation of existing populations.

An accurate estimate of current birthrates can be made in countries where virtually all births are registered. But no one can predict with certainty the future birthrate. It can fluctuate as rapidly as women can change their minds. Such unpredictable events as a power failure, a papal decree, a war, or a famine all influence the birthrate. It responds to new birth control technology—such as the pill or intrauterine devices—and to changes in abortion laws.

In much of the world today the primary influence on the birthrate is the attitude of the population toward birth control and family size. Methods for reducing the birthrate are available, and both private and public organizations are anxious to dispense them. Resistance to the diffusion of birth control methods comes from conservative religious and social organizations and from illiterate rural inhabitants.

In the developed regions of the world, and in parts of the less developed regions, recent changes in urbanization, education, and the role of women portend a drop in birthrates. The reduction of birthrates in cities (more generally, the reduction of birthrates for all species under conditions of high density) has been observed for centuries, but at no time has urbanization proceeded at such a rapid rate. Family size and birthrate are negatively correlated with amount of education. The increasing educational levels in many parts of the world should reduce birthrates there. Finally, modern women have increasingly begun to control their productivity—ranging from the growing number of working women in Socialist countries, to French women who refuse to wed and bear workers for the bachelor farmers of Brittany, to militant abortion advocates in the United States, to Latin American women who practice birth control without their husbands' knowledge.

The death rate fluctuates unpredictably, too. Disease, famine, war, and accidents all raise the death rate; sanitation and medical care, adequate crops and food distribution, peace, and safety measures all reduce it. The cause of the so-called population problem has been mainly the drop in the death rate, and especially the drop in infant and child mortality. In the less developed areas the introduction of minimal sanitation and public health measures, such as antimalaria and antiyellow fever campaigns, often leads to a major drop in the death rate. When many more infants and children survive, population grows rapidly, and within two decades these young reach reproductive age, compounding the population growth. In Europe and North America the death rate has fallen to 9 per 1,000 persons, and it probably will not change greatly; the less developed areas are slowly approaching the same level.

Yet any sunny statement about the control of death should acknowledge the persistent shadow of the great scourges of man, such as plague, cholera, and malaria. They have not been eliminated and strains resistant to medical techniques could sweep the globe at jet speed. And the never-silent drums of war and the awesome arsenals of the superpowers must remind us of the potential impact of a few men poised at a few buttons.

Some ecologically oriented studies of primitive tribes have shown the delicate balance between men and their environments, and how techniques of birth and death control—often masked in ritual and magic, in feud and warfare—maintain this balance. A major question for the human species today is whether a similar balance can be obtained on a global scale. At this time the population equation is out of balance, and the species is growing rapidly. Although many argue the opposite, man does have the technology and the food-producing ability to support a larger population. Unless global warfare or a major pandemic intervenes, the species will continue to expand for many decades. Ultimately, the population must return to a balance, to a point where the death and birth rates are equal. A major rise in the death rate is an unacceptable alternative for balancing the equation. A lowering of the birthrate is the only acceptable solution. In the broadest view, a most significant development in the status of the species must be the many indications that man has begun to control his birthrate in the developed countries, and that this trend has begun as well in the urban areas and among the educated people of the less developed countries.

* * *

In the following section of this supplement three aspects of the status of man today are presented. Dr. Irene Taeuber analyzes one of the world's greatest demographic puzzles, the peoples of China. Since nearly the beginning of civilized man, the Chinese have been the largest population group, and they continue to remain so today. Their slow, balanced growth for centuries, the impact of Communist control, and the indications of trends in birth control are studiously outlined. Dr. Henri Leridon examines the microcosm of the women of the island of Martinique to detect the implications of social behavior on fertility. The careful records of the civil government permit insights into the social problems of a less developed area—and these insights could be applied to similar populations in other less developed areas. The map and statistics on pages 60 through 62 provide some of the best estimates of the size and distribution of the world population today, as well as latest estimates of the future population by the Population Division of the United Nations.

The Chinese Peoples

By Irene B. Taeuber

Office of Population Research, Princeton University

In 1970, there is a deep crisis in the human species. Science and technology underlie a changing biological relation between man and nature. In the developed countries man has adapted to and modified nature, including his own reproductive performance; there is a swiftly increasing economic product and a slowly increasing population. In many of the less developed countries ancient institutions and behavior patterns continue while diffusing technologies cause rapid population growth, making change essential to survival. The coincidence of the reduced death rates of the modern era and the high birthrates of ancient eras yields rates of increase that can be sustained only briefly.

The Chinese population has been distinctive in persistence and in evolution over recent millennia. Today the vastly increased and increasing Chinese population is moving to modernize in a form of political and social organization that is both Chinese and Communist. How relevant are the policies and the politics of communism to the persistence, disintegration, or transformation of the family; the role of women; and the rate of reproduction? What are the impacts and the responses to the increasing numbers of people within China? What are the implications for continuity or change in rates of population growth, and the associated increase or alleviation of demographic tensions?

There are approaches, but no answers, to these broad questions of the future numbers of the Chinese. Births, deaths, and migrations describe the life cycles of men and lemmings, Aztecs and Egyptians, Hottentots and Eskimos, Europeans and Chinese. The questions to pursue through the prehistory and history of China are neither solely biological nor solely demographic. The involvements range through the physical, biological, and earth sciences to the social sciences—demography, psychology, history, and linguistics. Ethics and religion are related. What were the factors of locale, resources, culture, and population dynamics whereby the Chinese became, and remained, the world's largest cohesive ethnic group? Are the characteristics and capabilities that yielded survival, cyclical increases, and recurrent greatness in past periods adaptable in a present and a future where persistence may mean biological retrogression and cultural fragmentation?

The biological differences among the groups that formed the Chinese population are largely unspecified and unmeasured. Variations and changes were related to levels, patterns, and selectivities in marriage, fertility, mortality, and migration. Demographic continuity, increase, and expansion were related to integrated factors of location, climate, resources, culture, and political form. There was an efficient and enduring agriculture, an integrative social and economic order, and a sustaining matrix of values and ethics. The political organization was conducive to local stability, economic expansion, cultural diffusion, and national unity. Death rates were low enough to permit population increases in normal years and continuity in times of cataclysm, epidemic, famine, or conflict. There was recuperation in decimated populations and succession in devastated areas.

The efficient survival techniques of the Chinese were re-enforced by an adaptive fertility. The society was familistic, but the family was oriented to the continuity of generations rather than to maximum reproduction. The selective survival of the newly born, the priorities of sons, the absences of men, and the sex codes tended to hold fertility below levels that threatened family and group survival. The idealized vision of many sons may have been widespread in new agricultural regions or among peoples recently Sinicized. It was not the prevalent pattern.

The Ch'ing dynasty achieved hegemony in the middle of the seventeenth century. Peace, order, economic development, areal expansion, and the diffusion of new crops favored increasing numbers and expanding frontiers. There are many figures after 1741 when the *pao-chia* system of local registration was restored by the Emperor

Chien-lung. The reported numbers are usable in rough form from 1749 to 1851, when the spreading Tai-p'ing rebellion ended nationwide reporting. In 1953-54 there was an investigation and registration of the population of the Peoples Republic of China, with publication of totals for country and provinces. These population reports show a large initial size and generally increasing increments of such magnitude that they are difficult to comprehend. The population was perhaps 225 million in 1749; it was 430 million in 1851. In 1953 the figure for all China, including Taiwan, was 593 million. The rate of increase was low; two-thirds of one percent a year from 1749 to 1851 and only one-third of one percent a year during the next 100 years. If these figures are roughly correct, the Chinese increased almost 400 million in the two centuries prior to the recent thrust for economic and social modernization and the beginning of China's demographic transition.

Chinese painting of Taoist deity, ca. 1900.

In 1949, as in 1939, 1851, and 1749, the ratio of births to deaths was premodern. Along with the high level of mortality, fertility was high enough to sustain the population and to yield slow growth over periods of time. The prevailing mortality was influenced little by modern medicine, public health, or sanitation. Famines, epidemics, and floods were frequent if irregular occurrences. There were major regional variations in fertility and mortality even in favorable years. Expectations of life at birth must have been about 25 years. If so, and if there was slight population growth, intrinsic birthrates must have been somewhat above 40 per thousand persons per year. Long cycles and lesser fluctuations in rates of population change were explainable largely in terms of the factors influencing mortality. The century of disintegration and conflict that preceded 1949 maintained the ancient balance of births and deaths.

The consolidation of power and the transformations of the People's Republic of China quickly reduced death rates and temporarily stabilized or even increased birthrates from 1949 to 1957. There was relative peace, internal order, and a more regularized and widely distributed food supply. Health services were developed in ways that reached down to local levels. Cleanliness and sanitation campaigns eradicated specific carriers of disease. Internal reports and external studies corroborate the assumption that death rates were reduced swiftly, substantially, and widely. Reunited families, new marriages, reductions in infanticide, and higher status for girl babies all caused temporary increases in numbers of live births and in numbers of infants surviving.

The rapid growth of population, caused by the major decline in death rates and the persistence of essentially traditional birthrates, became the subject of dialogue and diatribe within China. The Communist government could not easily adopt an antinatalist population policy because the writings of Marx, Lenin, and Mao denied the tenets of Malthus. However, government birth control programs do not need the rationale of antinatalist and catastrophe-oriented statements of policy. In China, contraception, induced abortion, and sterilization were made available through the health services with health rationales.

Many ethical, social, and ideological developments were conducive to the adoption of population control practices. For instance, control of reproduction, including abortion, was a basic right of women; dedication to the party—or to the thoughts of Chairman Mao—involved a concentrated service that was incompatible with early marriage and the responsibilities of many children; duties of loyalty and service were as relevant to women as to men.

In theory, then, the path to a comprehensive population program was straightforward. In fact, publicity campaigns were episodic and halting. In the early years of the People's Republic of China inadequate means, quiescent motivations, and an insufficient infrastructure precluded either massive attacks or substantial achievements in birth control among the rural population. Neither the rhythm method nor conventional contraceptives diffused quickly among the peasants. The limited number of doctors barred major programs of induced abortion even if such programs would have been acceptable to the government and the people. However, the timing of rapid population growth in China has helped resolve the problems of lag between declining death rates and declining birthrates. New technologies of birth control available to the Chinese include the intrauterine contraceptive devices, suction techniques for induced abortion, and the pill.

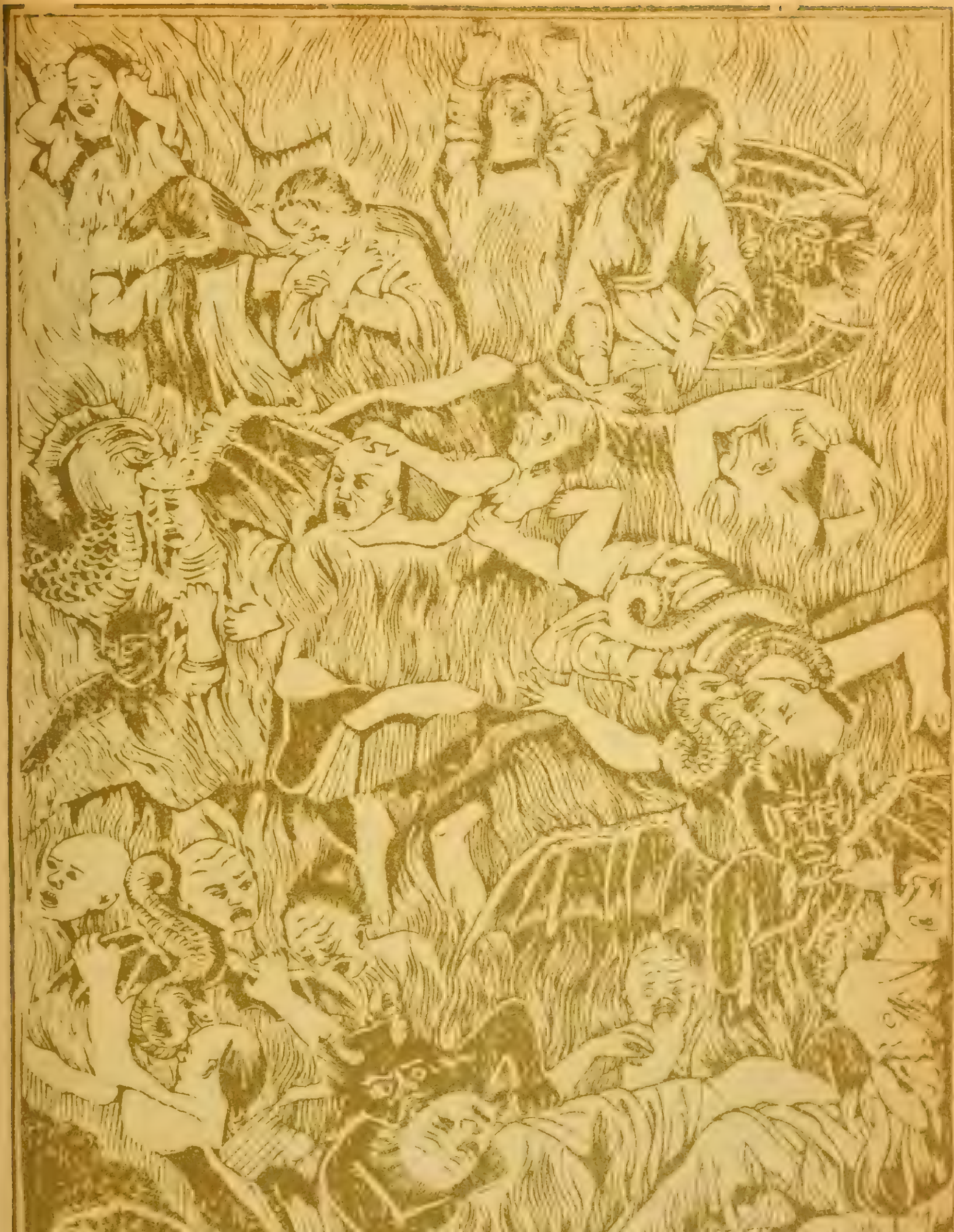
The balance of the evidence suggests that birthrates are declining in urban areas and that there are increasing changes conducive to reduced birthrates in rural areas. Declining fertility would first be manifest among the younger people. All those now below age 20 were born and reared in the People's Republic; no woman aged 20 to 29 today was more than ten years old when the Communist regime was established. Levels and trends in fertility are now dominated by the decisions and actions of women long conditioned to communism.

In the absence of quantitative information, statements about the levels and trends in birth rates must be conjecture. It seems unlikely that fertility has declined substantially in communes remote from cities. However, there are multiple and tenable bases for assuming that the fertility of the women in the communes will decline sooner and more rapidly than that of rural women in most other large and less developed countries. It should be stated explicitly, though, that these arguments are tenable only if there is external peace, internal stability, and economic advance.

Comparative analysis is difficult when it is based on statistics for other countries and conjecture for China. However, there is quantitative information for the years prior to 1940 on demographic, economic, and social relations in stable and migrant populations, in rural areas and in great cities, and in ancient and new areas for Chinese populations both within and outside the mainland of China. There are census and vital records for Chinese populations in Taiwan, Hong Kong, Singapore, and Malaysia in the postwar decades of rapid economic growth, social change, and declining fertility. There are increasingly precise sources on the dynamics of population change during a century of Japanese modernization—and Japan is a part of the Chinese cultural area. If relations can be assumed with logic and cultural plausibility, the impact of economic and social changes and urbanization on the fertility of the Chinese can be assessed.

What are the reasons for assuming developments favorable to the reduction of fertility in the People's Republic? Only a partial listing is possible here. There are the realities of low fertility in Japan and declining fertility in the Chinese populations around the perimeter of the People's Republic. In these areas, as in China, traditional fertility was adaptive. There are present memories of pragmatic infanticide; there is wide acceptance of induced abortion.

Given political coherence and economic development, the setting for the reduction of fertility may be even more favorable among Chinese inside China. The equality and the responsibilities of women were central drives in the ideology, the crusades, and the directives of the People's Republic, along with correlated assaults on those loyalties that sustained the traditional family, the subservience of women, and frequent childbearing. There were massive drives for education, with extensions of literacy, elementary schooling, and the participation of children in life outside the family. There was nationwide communication through press, radio, television, study, and discussion. There were blockages in urbanward migration and occupational mobility. There were the instabilities and insecurities of rural people without personal or family attachments to land. Successive expulsions eroded security within the cities. Migrant youths and former Red Guards



Woodcut from Chinese Jesuit text ca. *eighteenth century.*

who returned to the countryside or the frontier regions were unlikely to resume the traditional ways that supported high fertility. Clandestine urbanization and compulsory deurbanization diffused urban values, aspirations, and frustrations.

There is a further aspect of the demographic process itself that underlies anticipations of present and future changes in family life and reproductive levels. We noted earlier that those now reaching the ages of labor force participation, family formation, and childbearing were born under communism. Their increasing numbers may threaten the political stability and the economic viability of a nation still insufficiently integrated and largely undeveloped. Youths aged 15 to 24 in 1953 were the survivors of births from the years 1929 to 1938. Their numbers had been reduced both by the normally high mortality of the ancient regime and the additional mortality of the years from 1937 to 1949. Youths who will be 15 to 24 in 1973 were born in the years from 1949 to 1958. Initial numbers were larger and the depletions of death were reduced. Assuming continuity in fertility and declining mortality, the estimated number of youths aged 15 to 24 in 1973 will be 75 percent greater than the same age group in 1953. Although a decline in fertility can reduce the numbers of future youth, it cannot reduce the numbers of those now maturing. The political, economic, and social difficulties associated with the increasing numbers of youth may well contribute to the adoption of firmer programs and broader sanctions by government in the field of population control. Difficulties in employment, barriers to movement, and forced mobilities should deepen and extend the motivations for marriage postponement and birth limitation.

The projection of the future growth of China's population is peculiarly difficult. Estimations and projections from 1949 to 1970 involve acceptance or modification of the numbers from the registration of 1953-54; acceptance or modification of age distribution given then; and decisions as to hypothetical levels and changes in fertility and mortality. Projection from 1970 to 1985 or beyond involves the forward movement of a hypothetical construct. The process of estimation is facilitated by increasingly sophisticated methodologies for evaluating the dynamics of population from limited data and is guided by increasing knowledge of the demography of modernization in other Chinese and related populations. There must be compatibility with developments in such fields as health and agriculture. There must be consistency with fragmentary information from press, radio, personal reports, refugee interviews, and other reconnaissance activities.

The United Nations Secretariat has made many exploratory projections of the population of China. The median estimate in a recent series assumes an initial birthrate of 38, a decline in fertility in 1955 and later years, and a slowly declining death rate. Under these drastic assumptions, the population that was about half a billion in 1940 will reach almost three-quarters of a billion in 1970 and exceed one billion in 2000. A United States government estimate based on moderate economic development assumes a higher initial fertility with later and slower decline and a lower initial mortality with speedier decline. In the United Nations estimate, the population of China will be 883 million in 1985; in the United States estimate, the population will be 1.1 billion.

Comparisons with other, less developed countries suggest the distinctive aspects and the basic questions of the future of China's population. Numerical estimates are difficult, particularly if the task is the determination of the present rate of increase of the population. The pervasive figure for average annual growth has tended to be about 2 percent a year; the current estimate of the United Nations is even lower. However, there is major surety in the statement that current rates of natural increase in China are substantially lower than those in other massive and less developed countries. United Nations estimates and projections suggest that the populations of less developed countries outside China increased 29 percent between 1960 and 1970. Estimated decade increase was 27 percent for Middle, South and Southeast Asia; 37 percent for tropical, south, and mainland Middle America. Except for China, there are no demonstrable declines in the large, populous, less developed countries.

No imminent or future declines can mute the seriousness of the population growth now occurring in China. Communism and Chinese culture seem to have altered the timings and moderated the dimensions of the inital population growth and the early population problems of modernization. Time and statisitcs will tell whether the perspectives for the future are also altered.

Fertility in Martinique

by Henri Leridon
National Institute of Demographic Studies, Paris

Islands scabs on the waters
Islands evidence of wounds
Islands crumbs
Islands shapeless
Islands poor paper torn upon the waters
Islands fragments side by side thrust upon the
flaming blade of the sun. . . .
Aimé Cesaire, *Cahier d'un retour au pays natal*

The demographic history of the Antilles begins in 1492. Like a large part of the American continent, almost no trace of the original population remains today. White colonists, black slaves, Hindu workers—arriving in successive waves of varying impact—all contributed to the peopling of these islands scattered around the Caribbean.

If the whites brought their customs, their laws, their religion, and often their morality, the same thing did not happen with the people of color: only the Hindus, who came as independent workers, were able to preserve at least their religion and their traditions. As for the blacks, at first their status as slaves submitted them body and soul to their masters; then the abolition of slavery abruptly made them citizens of countries that were not theirs. The present state of Antillean societies clearly bears the profound marks of past violence and upheaval.

After three centuries of eventful history, the Antilles have recently experienced a period of relative calm, if not prosperity. Attention is drawn to them once again because demographic pressure has reached a rare intensity there. The density of the population of the large islands—Cuba, Haiti and the Dominican Republic, Jamaica, and Puerto Rico—varies from 67 to 296 inhabitants per square kilometer (1965 figures). For the smallest islands it reaches 567 in Barbados and 858 in Bermuda. Somewhere in between is Martinique with 291 inhabitants per square kilometer, or 320,000 in all. The average annual rate of increase is 2.5 percent for the Caribbean region as a whole, and the average annual birthrate is 39 per thousand.

Realization of their political responsibilities has probably been accelerated by the small size and insular character of the countries. They have launched family-planning programs in many places. But it appears that a necessary stage has often been skipped: understanding of the social milieu. Few studies have shown the profound complexities of Antillean societies.

In 1968 the National Institute of Demographic Studies in Paris undertook such a study in Martinique, one of the islands of the Lesser Antilles. It covered 1,600 women 15 to 54 years of age. Two difficulties are often encountered in this type of study: the absence of up-to-date information and the lack of complete civil documents to supplement the sometimes defective memories of those questioned. These two difficulties were surmounted in Martinique because of periodic censuses (the last done at the end of 1967), a complete civil registration, and a system of social aid that encourages women to keep their dossiers up to date—especially for those items that concern their family situations (matrimonial status, number of children, etc.) upon which their financial rights rest.

What then, are the diverse demographic consequences of the family structure in one island of the Antilles?

Certain of these consequences are revealed clearly by the official statistics: the percentage of illegitimate births, for example, is about 50 percent; the average marriage age is high, 30 years for men and 26 to 27 years for women; acknowledging a child, which makes the birth legitimate, may occur well after the child's birth. As significant as these figures may be, they do not describe the successive events in the lives of Martinican women. It is that description that I am going to undertake.

Women may be grouped into three age groups and four categories of matrimonial status:

1. Legally married women, including widows or divorcees who have not remarried. 2. Women in common-law unions. 3. Women in "visiting"

unions, but not living with a man. 4. Single women.

A typical sampling of 100 Martinican women in each of the three age groups shows the following proportions in the different categories:

Matrimonial Status	Age Groups		
	20-24	30-34	40-44
Married	23	55	70
Common-Law	9	16	15
Visiting Union	22	11	5
Single	46	18	10

In the 20 to 24 age group more women are in a common-law or visiting union (31) than are married (23). In the older age groups, the proportion of married women increases rapidly. This evolution may be retraced (in a simplified fashion) by looking at the matrimonial histories of the women.

Matrimonial History	Age Groups		
	20-24	30-34	40-44
No sexual union	38	10	3
Married, no other union	14	31	38
Married, other unions	9	28	38
Unmarried, at least one union	39	31	21

The previous two tables tend to mask a stability in the relationship of many women, who may have a union with only one man and often will marry him in later years. This is indicated in the following table:

Number of Unions	Age Groups		
	20-24	30-34	40-44
None	38	10	3
One	43	53	54
Two or More	19	37	43

The proportion of women who have had at least two unions does not increase significantly above the 40 to 44 age group; generally the unions tend to stabilize when the women are about 35 years old. If married women have had other unions, they usually had them before their marriages.

The percentage of women, 26 percent, who have had unions with other men before marriage is close to the percentage, 21 percent, who have

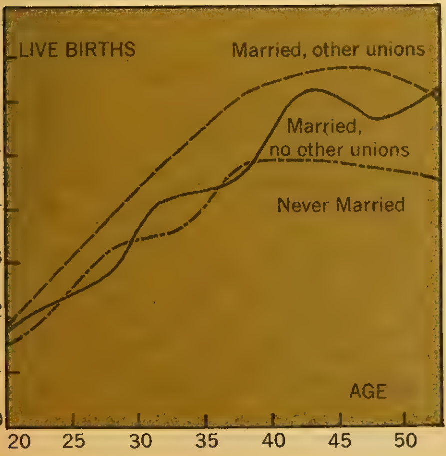
Primitive wood carving, Makonde tribe, southeastern Africa.

had children by other unions before marriages. The graph on this page shows the influences of age and matrimonial history on the number of live births among the women of Martinique. Married women who have had other unions—usually before marriage—have slightly more children. But in general this category and the other two—married women who have never had another union and unmarried women—tend to have nearly the same number of children until about 30 years of age. After 35 a clear difference develops: women who have never married practically cease having children, while the married groups continue to bear children for about five years.

A final table, showing the total time lived in a union, explains part of the differences on the graph:

Matrimonial History	Years in Union by Age Groups 30-34	Years in Union by Age Groups 50-54
Married, no other union	9.8	23.3
Married, other unions	10.7	25.4
Never married, at least one union	8.9	20.5

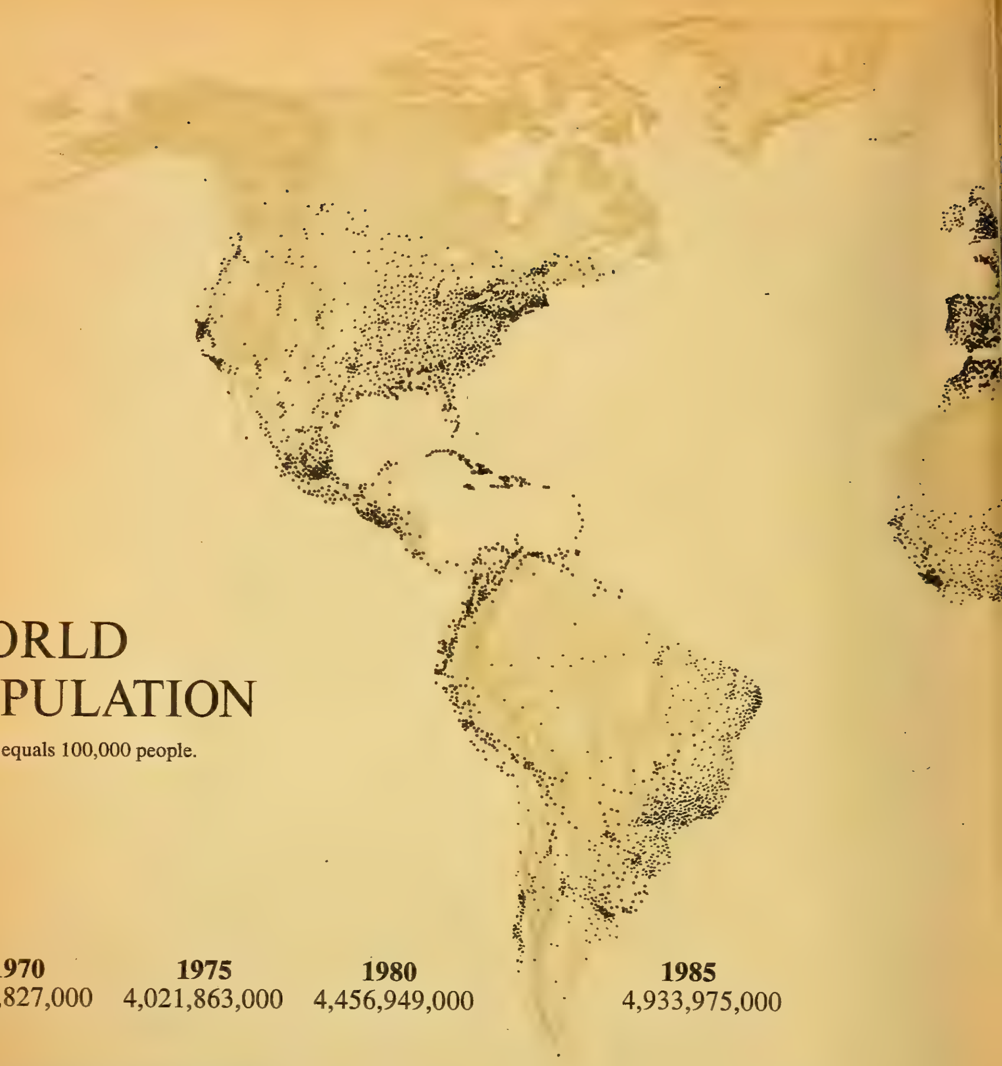
Both this table and the graph show little difference between the three categories in the younger years, while the unmarried group is significantly different in the older years. This difference is also revealed when the dates of the last birth are compared. The average unmarried woman gives birth to her last child when she is 34.5 years old, while the average married woman bears her final child at 36.5 years of age. In the light of these observations, and of several others, it seems that the important factor of differentiation in fertility is only indirectly the type of union; more directly it is the *length of time spent in a union*. Between successive unions a woman who changes her lover or common-law husband is likely to have a period during which she is not exposed to the risk of conception. A married woman, on the other hand, is continually exposed to this risk, until the dissolution of the union by the death of her husband, divorce, or separation. The probability of rupture for married women is less than for other types of union. For this reason, matrimonial status up to the age of 35 plays an important role: if a woman is not married at this age, there is little likelihood that she will still have children, because the chances are few that a man will choose her for a union.



So far I have reasoned as if the regulation of fertility were still entirely natural. This is no longer the case, although at present birth control has minor implications since so few women are able to use a contraceptive method with success. In this respect there is little difference between married and unmarried women. It will not remain insignificant in the future, however, because contraception will certainly spread throughout the whole population. The desire for contraceptive methods is strong, and the obstacles to their diffusion do not seem insurmountable. In this eventuality, how will fertility evolve? The answer will depend partly upon the evolution of matrimonial customs.

Already in the past half century, the age at marriage has fallen, while the proportion of persons who have never married has decreased. These factors favor a rise in fertility (or, if one prefers, a slowing of the drop in fertility).

It will be important to know the trends in the other types of unions. For the moment, our observations do not permit any conclusions on this point. Principally, evolution in the marriage pattern is a response to the wishes of women, who desire a stable union in which responsibilities (toward children, for example) will be more equally divided. That is why I believe that, in the future, marriage will become the type of union in which the concerns of the women will be taken into consideration, and their "family plan" best facilitated.



WORLD POPULATION

One dot equals 100,000 people.

1970	1975	1980	1985
3,631,827,000	4,021,863,000	4,456,949,000	4,933,975,000

These population figures are the median of three estimates made by the United Nations.

	1970	1975	1980	1985
Africa	**344,415,000**	**395,105,000**	**456,453,000**	**529,805,000**
1. Western	101,200,000	115,575,000	133,136,000	154,445,000
2. Eastern	97,882,000	111,852,000	128,758,000	149,212,000
3. Middle	35,893,000	40,385,000	45,787,000	52,463,000
4. Northern	86,608,000	101,459,000	119,385,000	140,093,000
5. Southern	22,832,000	25,834,000	29,387,000	33,592,000
East Asia	**929,932,000**	**1,011,210,000**	**1,095,357,000**	**1,181,722,000**
6. Mainland	765,386,000	832,387,000	901,354,000	973,026,000
7. Japan	103,499,000	109,948,000	116,347,000	121,346,000
8. Other	61,047,000	68,875,000	77,656,000	87,350,000
South Asia	**1,125,944,000**	**1,296,219,000**	**1,486,243,000**	**1,693,526,000**
9. Middle	761,809,000	875,462,000	1,001,045,000	1,136,874,000
10. Eastern	286,925,000	330,933,000	380,371,000	434,394,000
11. Western	77,210,000	89,824,000	104,827,000	122,258,000
12. USSR	**242,612,000**	**255,584,000**	**270,634,000**	**286,882,000**

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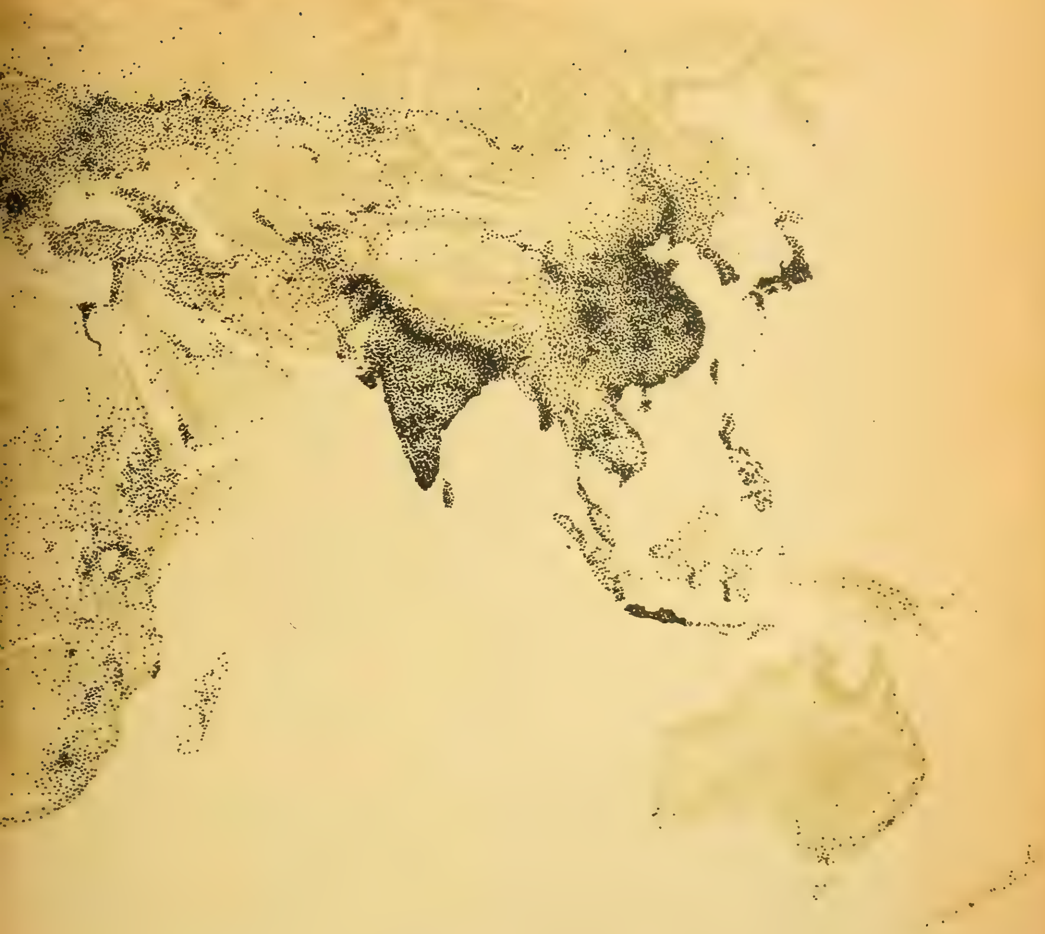
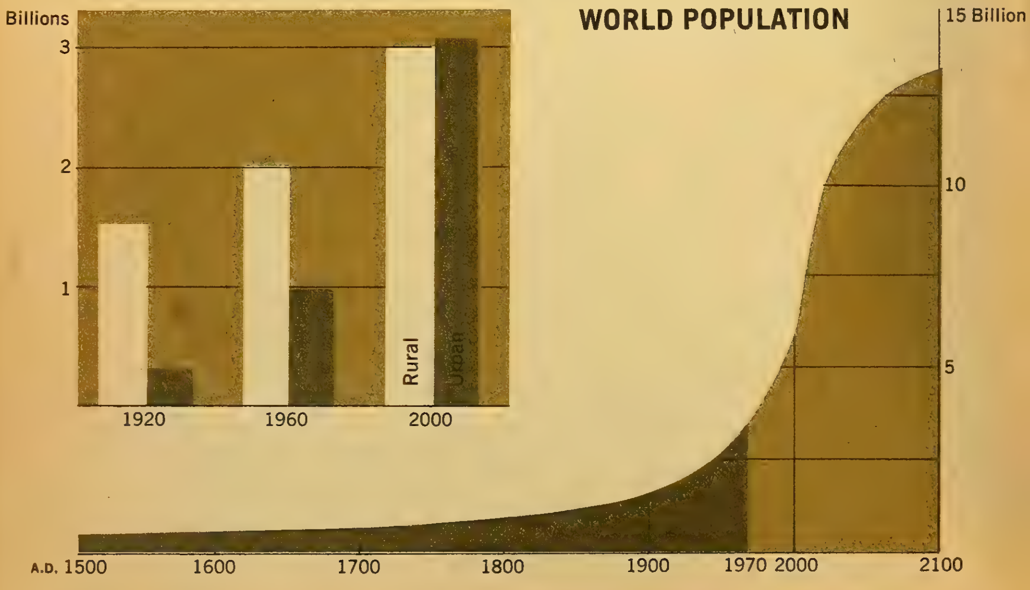


	1970	1975	1980	1985
Europe	**462,117,000**	**479,369,000**	**497,061,000**	**515,046,000**
13. Western	148,619,000	153,359,000	158,214,000	163,346,000
14. Southern	128,464,000	134,213,000	140,059,000	145,953,000
15. Eastern	104,081,000	108,227,000	112,392,000	116,148,000
16. Northern	80,953,000	83,570,000	86,396,000	89,599,000
17. No. America	**227,572,000**	**242,772,000**	**260,651,000**	**280,379,000**
Latin America	**283,251,000**	**326,834,000**	**377,170,000**	**434,634,000**
18. Caribbean	25,783,000	28,801,000	32,145,000	35,881,000
19. Mid-America	67,431,000	79,938,000	94,704,000	112,094,000
20. Tropical	150,659,000	175,159,000	203,591,000	235,947,000
21. Temperate	39,378,000	42,936,000	46,730,000	50,712,000
Oceania	**19,371,000**	**21,561,000**	**24,024,000**	**26,796,000**
Australia, New Zealand	15,374,000	16,982,000	18,785,000	20,745,000
Melanesia	2,767,000	3,147,000	3,583,000	4,120,000
Polynesia, Micronesia	1,230,000	1,432,000	1,656,000	1,931,000

BIRTH AND DEATH RATES AND LIFE EXPECTANCY

Region	Birth-rate	Death Rate	Life Expectancy	Region	Birth-Rate	Death Rate	Life Expectancy
WORLD	34-35	14-15	55-56	East Asia	32-36	14-16	49-55
Africa	48	22	40-45	Mainland	34-39	15-18	45-52
Western	54	27	38-42	Japan	18	7	71
Eastern	47	20	38-42	Other	36	12	63
Middle	44	23	38-42	South Asia	44	18	46
Northern	45	19	47	Latin America	38	12	56
Southern	41	16	51	Caribbean	39	14	51
Europe	18	10	71	Mid-America	44	11	55
Western	18	11	71	Tropical	40	12	54
Southern	20	9	70	Temperate	25	9	69
Eastern	16	9	70	Oceania	25	11	65
Northern	18	11	72	Australia, New Zealand	20	9	71
USSR	18	7	70	Melanesia	45	20	38-42
Northern America	20	9	71	Polynesia, Micronesia	40	10	50-55

Birth and death rates are per 1,000 persons. Life expectancy is in years. All figures are for 1965, the most recent year with complete data.



CONSTRAINTS ON THE SPECIES

Thomas Robert Malthus posed the problem when, in 1798, he wrote: "The power of population is indefinitely greater than the power in the earth to produce subsistence for man.

"Population, when unchecked, increases in a geometrical ratio. Subsistence increases only in an arithmetical ratio. A slight acquaintance with numbers will show the immensity of the first power in comparison of the second.

"By that law of our nature which makes food necessary to the life of man, the effects of these two unequal powers must be kept equal.

"This implies a strong and constantly operating check on population from the difficulty of subsistence."

Man has, for the past two centuries, disproved Malthus. Since he wrote *An Essay on the Principle of Population* the number of men on earth has increased from one billion to three billion. The graph of world population on page 62 shows clearly that the species has grown more rapidly than at an arithmetical ratio. The best estimates of the Population Division of the United Nations indicate that this growth will continue into the next century.

Man's ingenuity has disproved Malthus's argument that a shortage of food would act as a constant check on the population. In this century—particularly in the past two decades—technological advances in agriculture have enabled man to produce more than enough food—for himself and for future billions. In technologically advanced regions, such as the United States and Europe, the steady surplus of food has led to a reduction in farmland and farm labor. The introduction, during the last few years, of new seeds and more productive farming methods to Asia has already had a major impact on output, and raises the possibility of a surplus of food production there in the future.

Since he has been so strongly disproved, why do the ideas of Malthus persist? The answer is simple: Because Malthus was right—in principle. Man has the ability to reproduce at a geometrical ratio; and if man continues to do so unchecked for many generations, he will produce more than the earth can hold. Recent developments, which Malthus and most men of this century had not fully foreseen, indicate that food is not a check on the size of man's population. A crucial question for man today is: What are the significant constraints on the growth of the human species?

The Population Division of the United Nations has in the most tentative terms advanced a figure of 15 billion as the upper limit of human population on earth. The uncertain projection on the graph of world population shows a trend toward this figure in two centuries. This is only the grossest of estimates, and as yet no one has clearly analyzed the constraints or the processes that will bring about the inevitable reduction in the rate of man's growth.

* * *

In the following three articles, some of the constraints on man are discussed. Dr. Kendall W. King of the Research Corporation, a foundation for scientific research, shows in a detailed study of food supply in the Dominican Republic that the warnings of Malthus have immediate significance in parts of the less developed world. Gordon Harrison, officer in charge of the Ford Foundation's Resources and Environment Program, states that the constraints on population may be linked to the production and consumption patterns of modern man. He also asks if man may not already have an excess population. Finally, NATURAL HISTORY editor John P. Wiley, Jr. analyzes the possibilities for expansion of the species to other planets, and concludes that the cost and especially the great distance eliminate the possibility of a solution outside the biosphere for the problem of man's growth.

Malnutrition in the Caribbean

by Kendall W. King

Research Corporation

The ecologist tells us that the ability of a species to adjust to its ecosystem determines its chances of survival. We accept this readily in terms of other species: the highly developed reptiles once so numerous on the earth, but now extinct because of their inability to cope with a climatologically changing environment; or the jackrabbits, which deplete the resources of their range through overpopulation, then die back to manageable numbers by famine, disease, and predation.

It is harder for us to accept that man, like his sister species, exhibits these same phenomena. Yet, it is fruitful for us to look at many of our critical contemporary problems in this perspective. The conditions that have led to the almost universal shortage of food in the tropical belt can be useful examples for the study of man's maladjustment to his environment. Data from a 1969 national nutrition survey in the Dominican Republic demonstrate that point clearly.

In large areas of the world, man is increasing his numbers at a rate that forebodes famine should even relatively local drought or storms occur. In other large areas he is concentrating huge masses of his species into such compact urban centers that he is fouling his own environment to the point where it may well become unlivable.

For the past two centuries the species has imposed on its environment stresses of a kind, or at least an intensity, that are completely new. Sea lanes have been carved through the land masses at Suez and in Panama. Instantaneous verbal and visual communication has become worldwide. Fungi, once useless pests, have been coaxed into massive fermenters producing the antibiotics that permit control of many killer diseases. Chemists have tailor-made new molecules, some bringing the scourge of malaria under control, others boosting both the quality and the quantity of the food supply to new highs. Geneticists have given us animals and plants of unimagined agronomic value. One-by-one, the mightiest river basins of the world are being controlled.

But negating the benefits of all of these achievements are other events. By bringing medical care to primitive people, we have prolonged life so dramatically that the population growth is ominous. Misuse of potent agricultural chemicals threatens to overbalance their value. We have built atomic weapons to kill ourselves and added nerve gases and biological warfare agents to clean up the unhappy survivors. We make war as never before. The human institutions by which we do these evil or foolish things are essentially the same as those through which we ameliorate the harshness of our environment.

Looking at this ineptitude in our use of institutions makes me wonder if we aren't fumbling as pre-man must have when, over hundreds of thousands of years, he gradually brought use of his opposing thumb under control. The complexity of thought necessary to create and manage an institution being so many orders of magnitude greater, it is small wonder that the mind is so slow to bring institutions under control.

Nowhere is this need for searching thought more apparent than in connection with the gap between the world's supply of food and the number of mouths to be fed. Malthus may have been clairvoyant, or he may have been dead wrong because of an underappreciation of the capacity of man as a species to analyze his condition and then plan for its amelioration.

There is no one world food problem, and there is no one answer. There are innumerable problems and as many possible answers to them, but the answers cannot profitably be applied until the problems are understood. Any attack on malnutrition requires careful study, country-by-country (and in large countries, region-by-region). The aims of such a study are to learn what kinds of malnutrition exist, how severe they are, among what population groups they are found, and what factors are contributing to the condition. Without this solid basis of fact a reasonable attack cannot be formulated. After all, an attack on malnutrition really boils down to an attempt to adjust the position of man in an ecosystem.

An example of this approach is a national nutrition survey undertaken in the Dominican Republic in the summer of 1969. It is, perhaps, the most comprehensive nutrition survey that has been completed, taking six months of planning and seven weeks of intensive field effort. A survey of this type has purposes far beyond the simple documentation of malnutrition. To be sure, the conspicuous effort is to learn what kinds of malnutrition exist, how severe they are, and among what groups of people they are most common. Collecting this information requires the input of clinicians, nutritionists, and biochemists. It is also the purpose of such surveys to develop practical programs to control malnutrition, and to do that requires understanding of a maze of local cultural traditions; economic, legal, and educational systems; and the whole complex known as agribusiness.

Primitive wood carving, Ivory Coast, Africa.

The team was organized into a number of parties. The clinicians in the medical party examined a large number of people, using an extensive, specialized technique to detect nutritional deficiencies. The anthropometric party measured height, weight, and a variety of head, chest, and arm dimensions. Photographs of the glowing of the skulls when exposed to a stroboscopic flash from an 11,000-watt light measured the normalcy of brain and cranial development of young children. From every tenth subject blood and urine specimens were obtained for chemical analysis of 17 indices of nutritional status.

A dietary survey party daily measured every scrap of food eaten by 150 representative families and gathered information on their food attitudes. From these data and reference tables they calculated the actual nutrient intake. As a further check on the authenticity of the reference tables, they prepared a series of composite daily diets cooked in the traditional way for chemical analysis of all vitamins, minerals, and amino acids.

A food technology party studied the whole spectrum of the food-processing industry, and the infrastructure on which it depends, in order to learn the present quality and production volume of the industry, its credit and capital problems, and the influence of existing laws on it. This party also studied the importation and exportation of food, and the status of wholesale and retail food enterprises.

An agricultural economics team investigated the status of agribusiness on a wide basis, including production and marketing practices, land use and land tenure traditions, laws, rural credit programs, the scope of the agricultural extension service activities, import and export systems, and tax and other legislation bearing on the food supply.

Eleven localities were studied, each selected to give a balanced sampling of the country with intentional weighting to low-income groups. In all, 5,500 people were examined clinically and

550 biochemically. Thirteen hundred wrist X-rays, which indicate the role of bone growth, were obtained on children under five and women who had had multiple lactations. Stroboscopic cranial observations were made on 300 children under two years of age. Complete dietary surveys covered 150 families.

Final analysis of such a volume of data will take many months, but already the findings reveal a picture of malnutrition that is typical of the tropical belt and that clearly demonstrates how badly adjusted the human species can be to its ecosystem.

Nearly 20 percent of the women have advanced goiter resulting from inadequate iodine intake. Among children, as many as 34 percent in some areas are so poorly developed as to be regarded in an advanced stage of malnutrition. In some areas 40 percent of the adolescent boys had achieved less than 70 percent of their expected weight. Of the people studied biochemically only 2 percent had acceptable values for the various vitamins, proteins, and minerals studied. Sixty-five percent of the subjects were below normal in vitamin C, and 54 percent of the people were anemic, apparently as a result primarily of low iron intake. In eight of ten locations calcium consumption was less than two-thirds of the U.S. National Research Council's recommended allowances. The same was true of riboflavin, or vitamin B_2.

The picture, then, is one of widespread deficiency, of not just one, but of nearly all nutrients. At the moment the majority of the people appear to be eating enough to prevent the appearance of clinical famine, but they are functioning under suboptimal conditions and have little or no nutrient reserves. A prolonged drought or the loss of a major crop through hurricane damage could precipitate overt starvation. The country could deteriorate into the present condition of Biafra in weeks.

Paradoxes in this situation convince me of the fallaciousness of the idea that a free population of uneducated people will optimize its relation to the local food supply. Here we are confronted with an island people so sapped by inadequate iodine intake that advanced goiter is rampant, and yet the iodine-rich resources of the surrounding sea lie essentially untouched. In a tropical country where fruits rich in vitamin C should be easily available, 65 percent of the population is deficient in vitamin C intake. In a land of immense productive potential, agronomic prac-

Daily nutrient intake of low-income men, 18-22 years old, in rural areas of the Dominican Republic

NUTRIENT		*Canca la Piedra*	*Palmar Grande*	*La Higuera*	*Mella and Augostura*	*National Research Council Recommendation*
Vitamin B_2	mg.	1.4	1.2	1.2	0.36	1.6
Vitamin B_1	mg.	0.72	0.49	0.59	0.36	1.4
Niacin	mg.	8.4	4.2	7.4	4.1	18
Vitamin B_6	mg.	1.5	0.94	1.1	0.66	2.0
Folic Acid	mg.	0.26	0.058	0.069	0.076	0.4
Vitamin B_{12}	μg.	3.6	0.87	1.6	0.70	5.0
Vitamin C	mg.	54	27	56	16	60
Vitamin A	I.U.	<1030	<787	<946	<581	5000
Vitamin E	mg.	2.4	3.5	5.9	2.6	22
Iodine	mg.	0.46	0.13	0.12	0.17	0.14
Calcium	mg.	480	280	390	120	800
Magnesium	mg.	240	160	200	130	400
Iron	mg.	11	5.6	10	6.5	10
Copper	mg.	0.75	0.51	0.60	0.37	2.0
Zinc	mg.	8.6	3.6	8.0	3.0	10-15
TOTAL PROTEIN	g.	46	26	51	22	60

mg.=milligrams; μg.=micrograms; g.=grams; I.U.=international units

Data compiled from a typical daily intake of food prepared in traditional manner. Only four cases meet National Research Council recommendations.

tices are so poor that gross deficits persist even in the supply of calories and protein. As in most parts of the tropical belt where large numbers of people live on a subsistence agriculture, we are confronted with reasonably well-fed adults in homes where about half of the children die of malnutrition and its sequelae during the first five years of life. These contradictory situations are not unique to the Dominican Republic or the Caribbean. Rather, they are more or less descriptive of life in the whole tropical belt.

Higher education and income levels alone do not mean better nutrition. For example, in Haiti, which borders the Dominican Republic and has a similar physical environment, a large number of peasants live in a subsistence agriculture system. A detailed study of the nutritional status of the rural Haitian compared with that of the typical rural inhabitant of the Dominican Republic showed surprising results. Though poor by most standards, the Dominican peasant is considerably wealthier and better educated than the Haitian peasant, yet his diet is worse and his nutritional status poorer. In both countries many families usually have a supper of boiled plantain, the green banana common throughout the Caribbean. When you look into the Dominican pot all you see in the boiling water is plantain; but in the Haitian pot the plantain is mixed with a variety of leaves and buds gathered from the fields and roadsides. These extras add significantly to the vitamin and mineral intake of the Haitian peasants. The contrast demonstrates that formal education and wealth do not necessarily improve the adaptation of a people to their surroundings.

The best specific approaches to correcting the widespread malnutrition found in the Dominican Republic can only be identified after greater study of the data and discussion with Dominican officials. Two conspicuous solutions exist, for example, for control of goiters resulting from iodine deficiency. One is to add iodine to table salt; the other, to develop the seafood industry. Iodization of salt is only practical if essentially all salt is processed at one or a few refineries, and this is not the case in the Dominican Republic. Development of marine industry has its drawbacks, too. It is not simply a matter of launching boats and training fishermen but also one of finding capital, developing docking and processing facilities, expanding refrigeration equipment and market outlets, and generating a new food habit on the part of a whole nation. On the other hand, the development of a fishing industry could contribute to the solution of many other nagging problems, among them deficits in proteins, minerals, and vitamins.

In urban centers where the bulk of the food moves through commercial channels, iron and vitamin deficiencies can be attacked through fortification of basic foods such as corn, rice, and wheat. Such an approach, however, would do nothing for the 70 percent of the population that live as subsistence farmers completely outside the channels of commerce. For the latter, education in the production and consumption of indigenous foods, which could provide an adequate diet within their current limited means, appears to be the only reasonable approach.

In any of these attempts to bring the condition of human life in the tropical belt into concert with what the environment could produce, a pervading problem recurs. Few institutions to achieve this concert exist, and the people trained in the necessary disciplines and experienced in organizational management are usually in very short supply. Attacking the problems involves, in an elementary way, the creation of locally adapted institutions and the education of people who can function through them. This is inherently a slow and complex process ultimately leading to major changes in the relation of people to their habitat.

The data from such surveys define the degree to which specific populations of man are maladjusted to their ecosystems. The problem does not seem to me to lie simply in there being no satisfactory niche or even in the available niche being too small for the population. The discrepancy between what is and what could be appears to lie in the inept, naïve, and largely uncontrolled use of man's singular survival-giving asset, his brain.

Now that these problems can be analyzed, man can begin to solve them. But even before that, the organ that gave man his advantage through invention of controlled fire, the wheel, higher mathematics, controlled atomic reactions, and institutions to achieve communally needed tasks needs more than anything else to be refined and disciplined. Only by exploiting his mind, his one major evolutionary asset, can man overcome the urgent crises of our age.

The Mess of Modern Man

by Gordon Harrison
Ford Foundation

Because of the evident reciprocal connection between conservation and population growth, it has recently become popular to ask those concerned with degradation of the environment whether it might not be best if they spent their time beating the drums for contraception. Since I believe the human race has no problem more important than checking its growth, I cannot object to any new recruits to the cause of reducing baby production. Yet there is a danger in pretending that numbers are the whole problem. There is at least equal danger in the corollary that measuring the capacity of the environment to support people can rationally determine how many people we should produce.

Air and water pollution; the mounting accumulation of solid wastes; the esthetic desecration of the countryside by jerry-built subdivisions, shopping centers, billboards, and other commercial gimcrackery; the extinction of wilderness and wilderness dwellers by highways, motorboats, snowmobiles, and all the manifold instruments of human restlessness; the extinction of silence by airports and air hammers—all these phenomena are lumped together as environmental deterioration and considered a plague of overpopulation. But it is important that we distinguish among these problems, for they have different causes and invite different treatments.

The encroachment of people on unsettled land is clearly the direct result of an increasingly large and mobile population. This encroachment threatens the existence of other species once man's density reaches numbers sufficient to dominate the environment. It is reasonable to assume—although difficult to prove—that the human race depends for its well-being on the preservation of a considerable portion of the web of life on earth. How much is "essential" or how much might be destroyed without markedly impairing the quality of human life are, so far as I know, imponderables not now subject to scientific measurement. Ecological study that is trying to find the causes of stability in natural systems may throw some light on the problem. With precise knowledge of how energy flows through a natural system one might redesign such systems with different components or repair them after one or more parts are destroyed. Ecologists are making progress in investigations that could lay the foundations for a science of environmental management.

Almost no research, however, is under way on the effects of the environment on man. We know pretty well which poisons can kill us; we know little about which may make us sick over long periods of time; and still less about what kinds of environment are conducive to human well-being. Does, for instance, the taste that persists in city man for seeing a tree now and then indicate a prejudice the urbanite could safely outgrow or does it reflect a need basic to his nature? Lacking the facts on man's dependence on his environment, it is impossible to talk in any scientific way about what residue of unspoiled nature should be defended as the minimum for human welfare.

In man-space relationships the ratio of numbers to acreage is the essence of the problem. However, many environmental problems, including esthetic and chemical pollution, are not caused by overpopulation and will not be cured by birth control. The trouble is a flawed socioeconomic system—a system that concentrates on production and consumption and regards residuals of production and consumption as somebody else's business. Waste production is an integral part of the economic process and must be thought of, and dealt with, in that way. The dirt that pollutes water and air is nothing but matter that has become toxic or annoying because it occurs in a setting where it is not wanted. Manure on the farm fertilizes crops; in the lake it fertilizes excessive growth of algae. Hydrocarbons are indispensable in the gas tank; a menace to health in the air. Cans are great on the pantry shelf; a great nuisance by the roadside.

Where there are few people in relation to the land, the transforming and discarding of materials is seldom a menace. We talk then of throwing things away, and we think of "away" as anywhere we are not. But as people crowd together, each backyard becomes somebody else's front yard; there are simultaneously many more things to throw away and fewer places to throw them. Crowding, however, is not the essential problem. The lack of dumping grounds is only a reminder that we have a problem. The question that should be forced on our attention if we are ever to cope successfully with waste is how does waste occur? is waste necessary? We do not ask this urgently or sharply enough.

Many municipal officials, for instance, are worried about trash and garbage. But in everything I've read and heard they are worried almost exclusively about its disposal. The existence of solid waste is accepted as one of the facts of modern life. So long as the question is how to get rid of waste, the best answer we can hope for is short run. Since most of what we use ends up as solid waste, economic production is converting raw materials into garbage. It follows that in time we will be literally living in garbage. Moreover, the demands of an affluent society speed up the conversion process in two ways: first, simply by producing more goods and, second, by producing goods of ever shorter usefulness. For instance, packaging manufacture—a rapidly growing industry—specializes in converting materials into a form that may have only a few minutes of utility, such as the paper bag brought home from the grocery.

To solve the solid waste problem we must first ask how we can check the generation of waste. That question presents government, industry, and consumer with a choice of policies for making effective changes in production and consumption —changes that will reduce the volume of what finally has to be thrown away. If consumers had to face the real cost of disposing of disposable bottles, they might forgo the convenience of using them. Producers might reconsider the cost of recovering and reusing materials if the costs of burying them in the front yard and of exhausting the sources of fresh supply were counted properly among the costs of production. Government tax policies, including both penalties and incentives, could decisively influence such decisions by the private sector without resort to direct controls. My point, however, is not to offer solutions but to suggest the importance of asking the right questions.

Considering only the waste disposal problem, there seems to be no reason why a society cannot be operated with a high quality environment at any population density. Since costs increase substantially as one approaches complete recycling, high production costs and, therefore, a lower standard of living probably would occur at high densities. But pollution inherently does not impose a first constraint on population growth in this country. Long before the economic pinch of keeping the environment clean constricts human numbers, we will have populated such a high proportion of land that the green world we take for granted will be radically changed.

I do not know (and I think no one knows) what the consequences of these changes may be for the quality of human life. Possibly men can adapt. But why should they have to? Why should we run the risk? What is the advantage of so increasing our population? Why should we wish to extinguish the green world?

Rather than ask how many people the world can support, a rational policy might better ask what minimum number is needed to populate and operate a humane civilization. Most countries have no reason to want a larger population and stand no chance of profiting thereby. The problems of coping with added numbers in cities, schools, highways, parks, airports are apparent. The optimum population for many countries is almost certainly somewhat less than they now have. It would be difficult to prove by any standard that more might be better even though more is inevitable. The real constraints on population growth are already in effect; we do not have to wait for a more crowded tomorrow.

Space: A Barrier to The Species

by John P. Wiley, Jr.
Natural History

The good earth is not the only place in the universe where man can live. He probably can survive on at least one other planet in our solar system, and it looks more and more as if there are any number of planets in our galaxy with earthlike conditions—all man has to do is find them and get to them.

As the 1970's begin the problems and, more importantly, the costs make wholesale emigration to other planets a topic for discussion, rather than a plan for action. As of today man has the basic knowledge—if not the technology—he needs. In our solar system, he knows he can do it. Moreover, the history of the species is clear on exploration: If man can go someplace even with great difficulty, he does. He has crossed the Bering Strait and walked 10,000 miles, sailed the Pacific in small boats, died reaching both poles, descended six miles into the ocean, flown to the moon. It seems unlikely that he will stop now. Technology does not worry him. He has gone in a single lifetime from Kitty Hawk to the Sea of Tranquillity, and has no reason to think he has reached his limit.

Man has walked on the moon and found no unpleasant surprises there. By astronomical standards the moon is but a step away; the price of a round trip could drop to $10,000 per passenger by the end of the century. It is even conceivable that man may learn to "live off the land" in some future lunar colony, using solar energy to extract oxygen from rocks and raising his food in greenhouses.

Mars is so nearly suitable for life that speculation continues over whether it exists there now. Mars has traces of an atmosphere and clouds and is near enough to the sun to enjoy temperatures as high as 75 degrees Fahrenheit. It, too, is relatively close to earth.

Other possibilities in our solar system include Ganymede, one of the four bright moons of Jupiter, and Titan, a moon of Saturn. Both are as large as Mercury, and both offer some evidence of atmospheres. Beyond the solar system lie a hundred billion more stars in our galaxy. According to currently accepted theory, many of these are accompanied by planets, of which a significant portion would be earthlike. The theory has been strengthened by the detection of "unseen companions" with planetlike masses circling half a dozen nearby stars.

Armed with this knowledge, man is moving into space. As he learns, space travel will become both easier and cheaper. Engineers are now at work on two developments that will mark a transition from clumsy first attempts to more sophisticated methods of exploration. One is nuclear engines; the other, reusable rockets.

Fuel requirements for trips beyond the moon are staggering. A round trip to Mars using the now conventional liquid hydrogen and oxygen would require millions of tons of fuel. Nuclear engines, however, develop six million times the energy for the same weight of fuel and would reduce fuel requirements to manageable proportions. The United States is testing experimental nuclear engines, and expects to have operational models ready by 1977.

Today, manned space flights are incredibly expensive demonstrations of brute-force rocketry. Rockets are used only one time; each stage, with the exception of the last, burns up on re-entry into the atmosphere. Imagine what a coast-to-coast flight would cost if the plane were used only once. Costs will drop sharply once space stations are in orbit and reusable rockets shuttle between them and the earth.

An orbiting space station is critical not only as a basic step toward cheaper space flight, but also as the laboratory in which we will learn whether man can survive long periods in space. Fourteen-day flights allayed our worst fears about the effects of weightlessness and the dangers of the space environment, but we still do not know what would happen on a two-year voyage to Mars.

Weightlessness is no longer viewed as a potential barrier, but as a problem. On fourteen-day flights work tolerance was cut up to 25 percent as cardiovascular systems weakened; body weight dropped by as much as 6 percent; bones lost calcium and other minerals; and blood volume and red blood cell mass shrank.

High-energy radiation—cosmic rays, solar particles, and gamma, X, and ultraviolet rays—is the most exotic danger to be faced. (Passengers making transpolar flights on supersonic transports will face the same dangers to a lesser degree.) Radiation demolishes certain biological molecules, particularly in blood-forming tissues and bone marrow cells. It also damages reproductive cells. Worse, the effects are cumulative. A dosage that can be tolerated for a month may be fatal if endured for a year.

Shielding, the obvious answer to radiation on earth, is anathema on a rocket because it means extra weight. The surface of the earth is protected by its atmosphere, a natural shielding equivalent to about thirteen pounds for each square inch of surface. Shielding in the Apollo 11 command module was equivalent to only about one-fiftieth of a pound per square inch.

Other dangers are equally real, if less likely. That old favorite of science fiction writers, collision with a swarm of meteors, has happened to at least one United States space probe. The sudden cabin decompression resulting from a fair-sized hit would cause a dramatic, but survivable, emergency for a crew.

Doctors aboard manned space stations will be looking for other problems as well. What happens to the circadian rhythms apparently so firmly impressed in the bodily functions? Will psychic aberrations set in when men are cut off from normal sensory input for long periods of time?

More prosaic problems must be solved for long flights. Moon-bound astronauts carry their own air, water, and a succession of picnic-type lunches. Their various life-support systems are open cycle; they use oxygen and water only once and discard waste products. On long flights, it will not be practical to carry enough supplies for the entire trip. Cycles will have to be closed so that every resource can be used again and again.

For walks of several hours on the moon, an astronaut carries a backpack weighing (on earth) about 125 pounds. The life-support system in the Apollo spacecraft, designed for 10 days, weighs 1,100 pounds. Oxygen accounts for 640 pounds of this weight. For a trip to Mars, each man will require an estimated 10 pounds of food and oxygen per day. If six men have to spend 600 days on the round trip, this will amount to 18 tons.

Getting there is only part of the problem. Much of our solar system is off limits to man and probably will remain so. Mercury has no atmosphere and daytime temperatures are hot enough to melt lead. Venus's atmosphere of carbon dioxide is so dense that light rays are bent around the planet; surface temperatures reach 800 degrees. The Martian moons, Phobos and Deimos, are so small that they do not have strong enough gravity to retain an atmosphere. Some of the asteroids are larger, but none is more than a few hundred miles across.

The major planets are cold hells. Jupiter, Saturn, Uranus, and Neptune have atmospheres rich in hydrogen, helium, ammonia, and methane; temperatures range downward from 225 degrees below zero. Pluto is 4 billion miles from the sun; if it has any free oxygen, it must be frozen.

Man appears to be left with the moon and Mars. If he learns to live in temperatures far colder than any ever experienced on earth, he may extend his range to Ganymede and Titan. The moon and Mars are so inhospitable, however, that they may never be more than temporary homes for small bands of hardy scientists, the kind of men who sign up for stays in Antarctica. Aside from the cost of transporting large numbers of people to them, the moon and Mars are nearly impossible to colonize because of the scarcity, if not absence, of water and oxygen, and the presence of such hazards as unscreened radiation.

The moon has no atmosphere and gives no sign of water or life. Surface temperatures range from 250 degrees above zero to 250 below. A person standing on its surface is subject to radiation, solar-wind particles, even the hazard of meteoroids streaking along at five miles a second. Oxygen abounds in the rocks brought back by the Apollo 11 crew; presumably some way could be found to use solar energy to extract it. But none of the samples contained any water or evidence that they had ever been exposed to water. And even if the moon were more easily inhabit-able, it never could become another earth in terms of population: its total surface area is only about that of Africa's.

Although Mars remains the best prospect in the solar system for inhabitation, its assets are minimal. In his enthusiasm for the planet, man tends to forget that if he stepped out onto its surface without protection, he would not last long. Mars is smaller, colder, and harsher than the earth. Its explorers will face these hardships:

While summer noontime temperatures on the equator rise to 75 degrees, during the night no place on the planet is warmer than 32 degrees, and in some parts, the temperature may sink to 150 degrees below zero.

The atmosphere is extremely thin. Its pressure at the surface is about that found on earth at 100,000 feet.

Because the atmosphere is so thin, the Martian surface is bombarded with radiation.

Lack of water is another serious problem. Water vapor is estimated to be 200 times less abundant in the Martian atmosphere than it is in the earth's.

Free oxygen appears to be scarce.

The larger moons of Jupiter and Saturn are often mentioned as possible sites for future human colonies. Man knows little about them, although he may learn more when Pioneer spacecraft fly by Jupiter in the mid-1970's. It is certain, however, that they are colder than anything in human experience; surface temperatures are believed to range downward from 200 degrees below zero. The four large moons of Jupiter show enough surface markings in telescopes for astronomers to say they rotate only once in a revolution around their planet, just as the moon does around the earth. This means that darkness lasts for days and weeks, producing still colder temperatures.

Thus the solar system appears to offer only limited possibilities for extending the range of the species. The rest of the galaxy is something else. Many, even most, stars have planets and some of these must be habitable. A Rand Corporation study in 1964 estimated that the chances of finding a habitable planet within 22 light-years of the sun are 4 in 10. The same study estimated the odds of finding a habitable planet around Alpha Centauri—the closest star—at 1 in 9. But travel to the stars is not like travel to the planets; it is far more difficult.

Distance is an immense barrier to interstella travel. When astronauts kick out of earth orbi on the way to the moon, they accelerate to 25,00 miles per hour. Even if they could maintain tha speed, which Apollo craft cannot, it would tak 125,000 years to reach Alpha Centauri.

This kind of distance presents two basic problems: how to go and where to go. From th earth, planets circling other stars cannot be seen Large planets can be detected by indirect means but man has yet to determine their size an density, what kind of atmosphere they have (i any), and their temperature. The light from such a planet is overwhelmed by the light from its star. Although they are one or two hundred million miles apart, they appear almost immeasurably close when seen from a distance of trillions of miles.

If an interstellar ship carries a 60-inch telescope, the crew will not be able to detect and study planets until the ship comes within a light-year of a star. Changing these numbers does not eliminate the gamble inherent in such a trip. The crew will not know whether there is a habitable planet orbiting the target star until it completes the bulk of the trip—a journey almost certain to be one-way.

How to know where to go is peripheral to the basic, unsolved question of how to get there. Technology and economics are not the limiting factors; the fundamental laws of physics stop us. You must have a given amount of energy to accelerate a given mass to a given speed; there are no shortcuts. To achieve a speed that will get man to the nearest stars in centuries or even decades instead of millennia, the energy needed is on an astronomical scale.

How great are the distances? If we put the earth and sun—actually 93 million miles apart—on a table top with three feet between them, the nearest star is 140 miles away. Imagine crossing such a void.

Chemical rockets are out; it takes five pounds of chemical fuel to lift one pound of payload out of the earth's gravity. This does not sound too bad, not until you realize that you then need more fuel to lift that first five pounds of fuel. The Saturn 5 weighs 3,100 tons at lift-off; of this, 2,885 tons is fuel.

Nuclear fission engines are six million times more efficient but the fuel (heavy elements, such as uranium, that are broken down) is very expensive. Nuclear fusion is more efficient and the fuel (light elements, such as hydrogen, that are used together) is 1,000 times cheaper. Some day man may find a way to control fusion reactions and build engines using them.

Edward Purcell of Harvard has calculated that a perfect nuclear fusion engine could accelerate a starship to 0.98 of the speed of light—if its takeoff weight were a billion times its final weight. Chemical reactions release the energy of bonds between atoms; nuclear reactions release the energy of bonds between segments of atomic nuclei. The only way to take advantage of Einstein's famous equation $E = mc^2$ is to convert matter directly into energy. We know of just one way to do this: bringing matter and antimatter together so they annihilate each other. If we could devise a way to store antimatter (you cannot use matter to contain it, of course), we could achieve 0.98 of the speed of light with a ship that originally weighed only fourteen times its final weight. But to slow the ship down when the destination was reached, then accelerate and decelerate again on the way back to earth would require a takeoff weight 400,000 times the final weight.

The best evidence today indicates that man will never be able to travel at close to the speed of light. Only ships designed to be the home of innumerable generations will penetrate very far into our galaxy. But if man accepts slower speeds, he can someday make one-way trips to the nearer stars.

Freeman J. Dyson of the Institute for Advanced Studies at Princeton has worked out the arithmetic of using hydrogen bombs as a means of interstellar propulsion (bombs are the only way now known to release fusion energy). He would use 300,000 bombs in ten days to accelerate a ship with a payload of 50,000 tons to 5,000 miles a second. At this speed the travel time to Alpha Centauri is a feasible 125 years.

In Dyson's scheme the bombs would be exploded every three seconds about six miles behind the ship. Explosion debris would strike a hemispherical pusher plate on the ship's stern and the energy would be transmitted through shock absorbers to give the ship smooth acceleration. The payload is large because Dyson assumes the ship would carry several thousand colonists with all their equipment and supplies for starting life on a new planet. He does not foresee any great wave of emigration though space; to send out a single such ship today would, in his estimate, cost a tenth of the U.S. Gross National Product. He does not think the trip will be made at all until its cost represents 1/10,000 of the GNP, the cost of a Saturn 5 today.

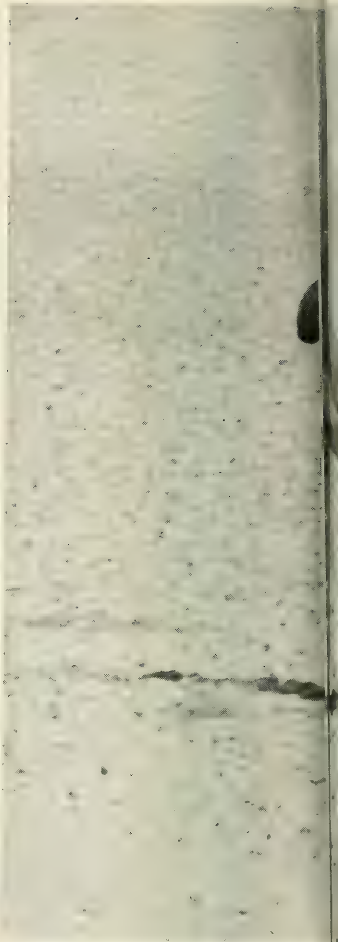
With the rest of our solar system inhospitable to life as we know it and with travel to the stars problematical, man must lie in the bed he is making on earth for the foreseeable future. No one is planning to colonize other planets. But, perhaps like the first organism to crawl up the beaches from the oceans, man is taking his first tiny steps into space. The United States is adopting a space policy that will allow it to decide in this decade when to send men to Mars. The Soviet Union, in its rare public pronouncements, talks of space stations and flights to Mars. Man may never extend his range beyond the earth, but it will not be for lack of trying.

Earth rising over lunar landscape.

BE FRUITFUL, AND MULTIPLY, AND REPLENISH THE EARTH, AND SUBDUE IT; AND HAVE DOMINION OVER THE FISH OF THE SEA, AND OVER THE FOWL OF THE AIR, AND OVER EVERY LIVING THING THAT MOVETH UPON THE EARTH. AND GOD SAID, BEHOLD, I HAVE GIVEN YOU EVERY HERB BEARING SEED, WHICH IS UPON THE FACE OF ALL THE EARTH, AND EVERY TREE, IN THE WHICH IS THE FRUIT OF A TREE YIELDING SEED; TO YOU IT SHALL BE FOR MEAT. AND TO EVERY BEAST OF THE EARTH AND TO EVERY FOWL OF THE AIR, AND TO EVERYTHING THAT CREEPETH UPON THE EARTH, WHEREIN THERE IS LIFE, I HAVE GIVEN EVERY GREEN HERB FOR MEAT: AND IT WAS SO.

Genesis 1: 28-30

A BIRD IN THE HAND



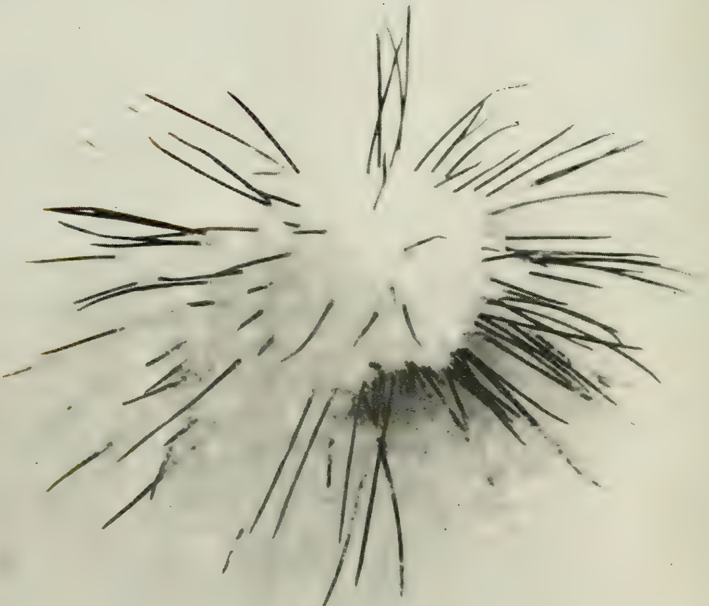
Flamingos—whether in Africa, America, Europe, or Asia—choose nesting sites in shallow alkaline water, where they can find the tiny plan and animal organisms that make up their food supply. Normally, thes sites remain water covered, but at times, they dry up, forcing the bird to seek other food sources.

At Etosha Pan, a stream-fed salt lake in South-West Africa, an unusually hot winter caused the water to evaporate from the flamingos nesting grounds before the young could fly. Without water and food, th 100,000 birds in the colony began to weaken and die. Those along th fringes of the dried lake fell prey to lions, hyenas, and jackals.

Launching a rescue operation, local game rangers began transporting the flamingos to Fischer's Pan, an amply filled lake twenty miles distant A crew of rangers and forty assistants set up temporary camps on the dried flats of Etosha Pan; then using their hands and nets, they captured about a fifth of the flock and loaded them into transport vehicles. The operation succeeded in saving the flock of flamingos.

Catching the birds by net was more efficient, but hand capture was more invigorating and spirited—at least for the rescuers.

evergreen



review

by Lorus J.
and Margery Milne

In autumn, most of the familiar trees and shrubs of North America lose their leaves in preparation for winter. Herbaceous plants die back to their roots, and annuals survive only in their seeds. Evergreens, however, continue to photosynthesize as long as the temperature permits them to conduct water through their stems. In spring, they have no need to wait for new buds to unfold before benefiting again from the life-giving light.

To be evergreen, a plant must keep its living leaves for more than twelve consecutive months—until new leaves have opened. In the North Temperate Zone we are used to the spectacle of autumn colors, with golden aspens and flaming maples contrasting with such evergreens as pine and spruce. In the Tropics, though, and in the South Temperate Zone the evergreen habit is the normal state of affairs, for most plants are green in all seasons. There, unless rainfall varies widely—from deluge to prolonged drought on a regular schedule—there is no periodic need for plants to shed leaves. Each leaf reaches old age on its individual schedule and drops off. The year has no fall to signal the change from summer to winter, and often no obvious springtime to greet another period of rapid growth. Thus, a tree or shrub that is deciduous in Canada may "become" evergreen if successfully transplanted to a location nearer the Equator.

Most deciduous and herbaceous plants have a fossil history of no more than about 100 million years. But most land plants with a history of 200 million years or more are evergreens. This has led scientists to believe that the long-lasting evergreen leaves follow an ancient custom, and that the deciduous habit is comparatively new and probably more advanced.

In northern lands where snow covers the ground to a moderate depth each winter, the lowly plants include many that are evergreen. Like the trees, they are perennials with strong stems. Tolerant of cold, they get enough light through the snow to melt any crystals in actual contact with them, and to use in photosynthesis. Next to their dark green leaves is a thin layer of air almost saturated with water vapor and rich in carbon dioxide, which diffuses out of the soil where the agents of decay are active throughout the year. Thus, conditions are almost perfect for photosynthesis, and these evergreens may accomplish most of their annual growth while snow is still on the ground.

One of these diminutive evergreens is a common club moss, known also as trailing evergreen, or Christmas green, which the colonists dug out of the snow each winter to form into lasting wreaths or to decorate their tables. Never sure of the proper identity of this fern ally, they also called it ground pine or ground cedar. It is native to dry woods and thickets in cool parts of the New World and the Old.

Under the snow, the leathery oval leaves and red fruits of another evergreen wild flower—wintergreen—offered the colonists a pleasing aromatic flavor. (Today's wintergreen flavoring is a synthetic substitute and stronger than the flavor that anyone exploring the forests can expect from chewing the young leaves.) American wintergreen is a broad-leaved member of the heath family, of a genus (*Gaultheria*) unknown in Eurasia. The evergreen plant known in Britain as wintergreen (*Pyrola*) is called shinleaf in America; it belongs to a different but closely related family.

When broad-leaved, lowly evergreens from warm humid climates are transplanted to regions where winters are dry and cold, they are more likely to retain their foliage under the snow than above it. English ivy (*Hedera helix*), for instance, survives as a ground cover far north and inland (away from humid coastal breezes) of its limit as a vine upon the wall. Periwinkle, or running myrtle (*Vinca*), from southwestern Europe, and *Pachysandra*, a member of the box family (Buxaceae) from the southern Appalachians, tolerate the cold as long as snow protects them from desiccation. By contrast, hedges of boxwood (*Buxus*), from southwestern Europe, and of privet (*Ligustrum*), from Mediterranean countries, drop their leaves and survive as deciduous plants where the winter weather is too dry for them to remain evergreen. Decorative kinds of holly (*Ilex*) are generally evergreen as far north as they can be grown; other hollies are regularly deciduous.

Rhododendrons and mountain laurels are among the few broad-leaved evergreens native to cold climates. Their tough leaves are well adapted to retaining moisture, to shedding snow, and even to supporting a glaze of ice from a freezing rain. They have a heavy cuticle to keep their upper surfaces waterproof, and comparatively few "breathing pores," stomata, through which water can be lost. These features are more highly developed among those evergreen trees that have needles, scalelike leaves, or mere prickles.

In the Northern Hemisphere, the preponderance of needle-leaved trees (and those with scalelike and prickly leaves) have cones; botanists have thus grouped them as conifers in the order Coniferales. Pines, firs, spruces, cedars, cypresses, and similar trees and shrubs belong to this order. They are easy to recognize by their leaves and cones, both of which are loaded with sticky, aromatic resins that repel most herbivorous animals. Mature cones are usually so hard and compact that the seeds within are well protected. These are borne, often in pairs, on the thick cone scales—modified leaves arising in a tight spiral form from a short stem. Only a squirrel is likely to tear a cone apart, or a crossbill to use its peculiar beak to reach in between the cone scales and eat the seeds.

In the Southern Hemisphere, most evergreen trees, while belonging to the order Coniferales, do not have cones. Instead, these pinelike trees bear solitary, naked seeds that could be mistaken for small plums.

Conifer is an appropriate term for most evergreens and for those few needle-bearing trees—the larches of northern swamps, the bald cypresses of the south, and the Chinese water fir—that shed their leaves. (A little care is needed to refer to these exceptions as "deciduous conifers," rather than the contradictory "deciduous evergreens.")

Presently, the land plants of the world are divided unequally between about 675 species of gymnosperms, plants with essentially "naked" seeds, and more than 250,000 species of angiosperms, flowering plants with seeds enclosed in fruits of one kind or another. These range from daisies to sugar maples. The 675 gymnosperms include more than 520 species of conifers, as well as about 100 species of ancient cycads, and the maidenhair tree (*Ginkgo biloba*). The balance of the gymnosperms are in three evergreen genera (*Ephedra, Welwitschia,* and *Gnetum*). The maidenhair tree and a handful of deciduous conifers drop their leaves in autumn; the rest are evergreen.

Cycads are primarily tropical trees resembling tree ferns or small palms. Their evergreen leaves, or fronds, have a long central midrib, along both sides of which narrow, glossy leaflets extend and hang down. Cycad fronds are marketed in many countries as "palms" to be carried on Palm Sunday, taking advantage of their remarkable resistance to wilting even when exposed to dry air and hot sun. Not only are the outer surfaces glossy with a thick cuticle, but the stomata are sunken in pits on the underside of the leaflets. The leaf stalk itself contains a system of mucilage ducts from which an effective sealing compound emerges when a frond is detached from the plant, preventing it from losing water through its conducting tissues.

The commonest evergreen "palms," grown in tubs in hotel lobbies around the world, are the cycads *Cycas revoluta,* of southeastern China and southern Japan, and *Dioön edule,* of Mexico. *Dioön* plants may be 1,000 years old by the time they are six or seven feet tall. Their starchy seeds can be ground into an edible meal. Starch of the granular sago type is commonly obtained from the pith in the trunk of other cycads. The only cycad native to America north of Mexico is the Seminole bread plant or coontie (*Zamia floridana*) of southern Florida, which has a completely subterranean starchy stem.

During the first half of the age of reptiles, from 230 to 135 million years ago, land plants consisted of cycads and members of now extinct gymnosperm orders, in addition to tree-sized ferns, and fern relatives. So far as we know, all of them were evergreen. Herbivorous dinosaurs found little else to eat. Yet in the second half of the reptilian era (the Cretaceous Period) the gymnosperms were largely displaced by flowering trees, shrubs, and herbs, except in regions where the climate remained cool for much of the year. There the conifers remained dominant, and upheld the evergreen habit to the present day.

In trying to account for the seemingly sudden change toward production of cones on the one hand and of flowers on the other, scientists have long hunted for some powerful factor in the Cretaceous environment that could have forced the appearance of these novelties. Dr. Verne Grant, a specialist on pollination who now directs the Boyce Thompson Southwestern Arboretum at the University of Arizona, suspects that the new feature was beetles. These insects, which today comprise the most varied and successful order of living things, appeared and quickly diversified during the Cretaceous Period. Dr. Grant believes that they became increasingly destructive to the reproductive process in ancestral seed plants. Seed plants needed new adaptive features to survive this onslaught.

The conifers adapted by simply shutting out the insects. Developing both hard parts and resin they continued to rely upon wind to spread their pollen and seeds. They retained their habit of slow, woody growth and evergreen foliage, which gave them many years to succeed in reproduction. The angiosperms enclosed their developing seeds in a curl of modified leaf and took animals into partnership. With special leaves, which we know as petals and sepals, they attracted insects, birds, and certain mammals such as bats to a banquet of sugary secretions (nectar) and surplus pollen. The animals evolved matching habits, visiting flowers regularly and carrying pollen from one angiosperm to the next.

Where the climate is always humid and warm, the evergreen gymnosperms could scarcely compete with the flowering plants, whose blossoms were sought out by pollinating animals. The waxy-leaved cycads held out where the air was dry enough to give them some advantage over the broad-leaved angiosperms. The gymnosperms found their future chiefly in areas where the soil was poor, in the temperate regions, along the fringes of the Arctic and Alpine zones, and on remote islands to which comparatively few kinds of angiosperms had spread. Tolerating the low humidity both winter and summer, trees with needlelike leaves, green scales, or prickles could grow in dense stands with little competition. Wind then could attend to their pollination in the old-style way.

Conifers now make up more than three-quarters of the world's gymnosperms, including all the well-known and commercially important kinds. They grow in a pattern resembling a figure eight when plotted on a world map. One wide loop stretches across North America and Eurasia, encircling the tundras around the North Pole; the other skirts the Pacific Ocean, including New Zealand and parts of Australia and South America. Outliers in the southeastern United States, in the Alps and other mountains of southern Europe, in South Africa, and in Asia (particularly from the Himalayan slopes to the mountains of Borneo) are isolated relicts from a once broader distribution.

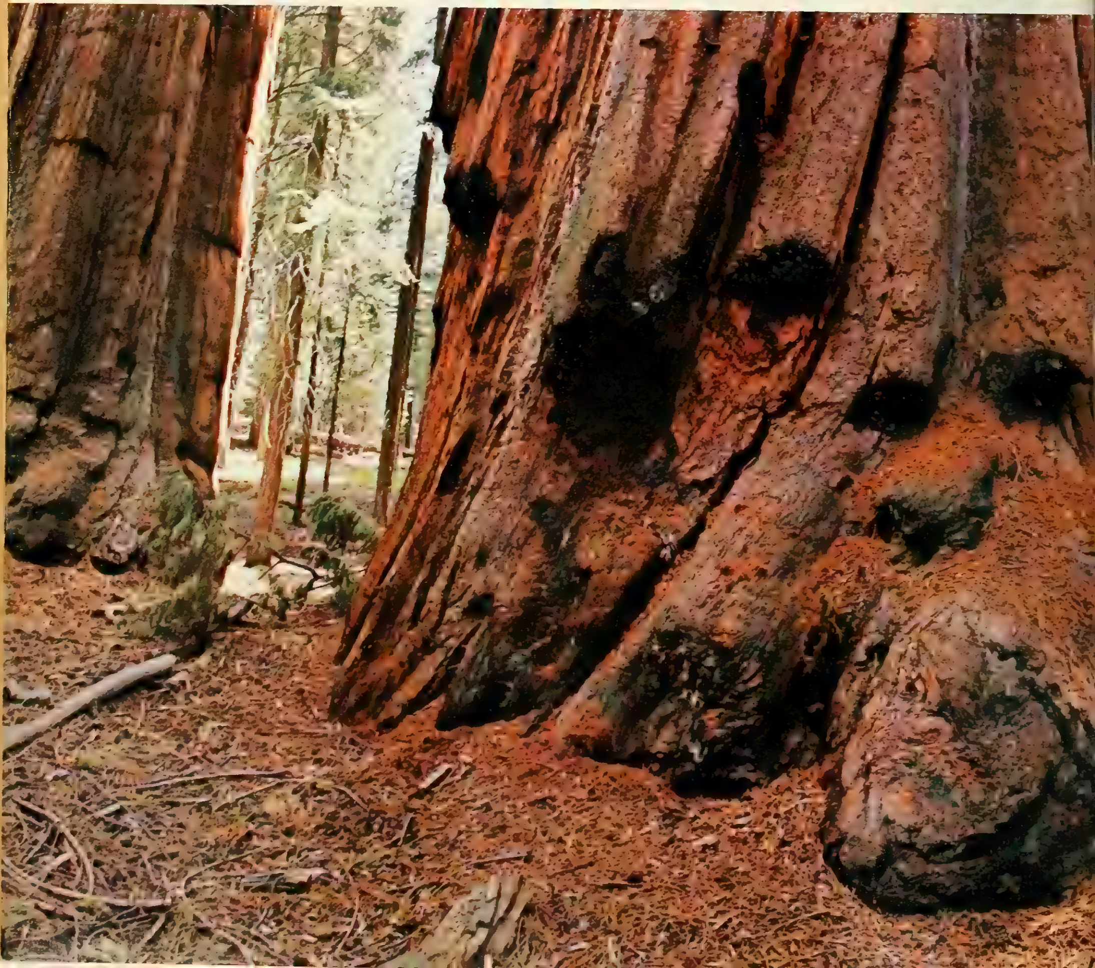
Generally cooler weather during the Ice Ages allowed conifers to grow at lower altitudes and latitudes, but they were largely replaced by angiosperms as temperatures warmed. Since the Ice Ages, members of the pine family (Pinaceae), have held their ground better than most other conifers. Often the pines form dense forests consisting chiefly of one or two species of the family.

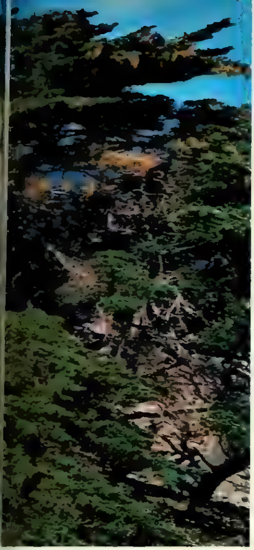
Some conifers have been almost exterminated in their native lands. The earliest record of such intensive cutting relates to about 900 B.C., when King Solomon sent "four score thousand hewers" into the adjacent

Moss-covered white fir, left, growing with sugar pine and incense cedar. Below, bald cypress.

kingdom of Lebanon to cut impressive cedars (*Cedrus libani*) for the construction of his temple. Only one small, protected grove of this famous tree now remains in Lebanon, to justify its display on the official seal and flag. Stands of the same cedar in less populated parts of Turkey are being rapidly felled. Fortunately, cedars of Lebanon have been introduced into botanic gardens all over the world and grow well far from home.

Similarly, the largest forests of Monterey pine (*Pinus radiata*) today are in New Zealand and South Africa, where they have been set out for afforestation programs on previously bare land. On its native ground, the Monterey Peninsula, it is an endangered species.





The principal coniferous forests not yet exploited are in western North America. Smaller areas grow in some Asiatic parts of the USSR and in Scandinavia. Elsewhere, second-growth coniferous forests with smaller trees have sprung up and are now attaining commercial size.

At present in North America, a system of "tree farms" for fast-growing evergreens and the scientific harvesting of forests have done much to bring into balance the rates of cutting and regrowth. In most cases, though, these managed areas bear only a remote resemblance to virgin coniferous forests.

Many of the most commercially valuable mature forests in the United States are on lands administered by the Forest Service. Commercial operators, mindful of the growing lumber markets brought about by a continually increasing human population, keep seeking ways to gain access to the trees on these public lands. Today, however, when cutting is authorized, as was recently done in a national forest along the Yukon River in Alaska, forest administrators often come in for severe criticism by a public with a growing environmental awareness. They are reminded that, in addition to functioning as a source of timber, national forests have other uses: watershed protection, flood prevention,

Monterey cypress, left. Giant sequoia with fire-charred bark, below.

Bristlecone pine (oldest living species), above. Left, southern evergreens: live oak and Spanish moss.

soil and wildlife conservation, and as esthetic refuges for citizens fleeing the urban environment. All these interests are adversely affected when lumbering operations begin.

Tall, straight pines are among the most valuable timber trees. Each of the world's ninety or so pine species differs in the details of its needlelike foliage, cones, resin, bark, and way of growth. Each species fits the land to which it is native. A forest of eastern white pine (*Pinus strobus*) is magnificently adapted to the glaciated rocky countryside of Maine and other portions of northeastern North

America; one of longleaf pine (*P. palustris*) to the sandhills of the Carolinas and coastal Georgia; one of western yellow pine (*P. ponderosa*) to the cool mountain slopes of the Rockies; and one of bristlecone pine (*P. aristata*) to timberline heights of mountains in California, Nevada, Utah, and Colorado. Each partakes of the environment where its ancestors have lived so long.

The eastern white pines grow close together from tiny seeds with a paper-thin wing. Wind propels them and often drops them on land that has been cleared by fire or man. After a year they are an inch tall; after ten, perhaps a foot. Then, in concert, they rise more quickly. In another decade or two they are competing for light. Their tops, exposed to the sky, stay green. Their lower branches die in the shade, and the dead stubs drop off. Straight upward, with no knots to mar the wood, the pine rises as high as 220 feet. During the seventeenth century, the best of the eastern white pines were reserved in the name of the King of England and became masts for British naval ships. The tops, with the long slender cones and the silky-soft green needles, were left to rot on the forest floor. The felled trunks were hauled off on huge wheels to the nearest port. Today many a New England community still has a "mast road" between the site of the pine forest and the highway to the sea.

The bristlecone pine has a growth pattern that contrasts sharply with the eastern white pine. Situated on the windswept mountain barrens, the bristlecone's trunk and branches are gnarled and twisted. This tree, seldom exceeding a height of 30 feet, retains its needles and clings to life for an extraordinarily long time. The foliage encircles the branch so far back from the growing tip that settlers spoke of it as a "foxtail pine." For 4,000 years or more some part of the tree may retain its youth, producing new needles and cones each year and adding another ring to the record of its age. Eighteen bristlecone pines older than this have been located and protected; one that was 4,900 years old, the oldest tree ever found, was inadvertently cut down. These patriarchs were seedlings when the Great Pyramid was built in Egypt. The woody skeletons from dead bristlecones in the White Mountains of California have made it possible for scientists to measure their ring thickness, and hence to determine weather conditions as far back as 6000 B.C.

The ponderosa pine forest that crowns the Kaibab Plateau on the north rim of Grand Canyon, isolated from other forests by deep canyons on three sides and by semiarid lands to the north, has maintained its virgin character. Here big squirrels with tufted ears and white bushy tails have evolved into a distinctive species, found only among the evergreens on this one plateau.

Across the canyon, fourteen miles away and 1,000 feet lower in altitude, the more arid south rim supports an entirely different pine forest. Instead of 150-foot ponderosas, with great open crowns and five- to ten-inch-long needles in bundles of three (or occasionally two), and three- to six-inch cones, the pines of the south rim are barely forty feet high, their contorted branches more densely covered by needles and their cones less than two inches long. Most are piñon pines (*Pinus edulis*) with two needles in each cluster. Some are single-leaf pines (*P. monophylla*) with just one needle at each site. Both produce large edible seeds called piñon nuts, which the Indians used to gather as a winter food. Now these "Indian nuts" are collected mostly for sale as tourist novelties.

The number of needles in a cluster, wrapped around at the base by a membranous cuff, is a good guide to the kind of pine. White pines have needles in clusters of five; yellow pines in clusters of three. The white pines include the longest-lived (the bristlecones), and the tallest (both the western white pine, *Pinus monticola*, and the sugar pine *P. lambertiana* attain 200 feet); they also include conifers with the longest cones (again, the sugar pine). A sugar pine cone eighteen inches long and six inches in diameter is the perfect trophy from an evergreen forest in Oregon or northern California.

Yellow pines are now major timber trees, with western yellow pine second only to Douglas fir in terms of supplying raw timber. Eastern yellow pines contribute a slightly larger volume, but consist of four different kinds of trees in forests of the American southeast. One of them is the longleaf pine, whose wonderful needles may be fourteen inches long, with cones, six to ten inches in length before they open. On seedling longleafs, the tufts of upright needles thrust up through the tall grass, and are said to be in the "grass stage" when they survive as evergreens after the grass itself withers and turns brown for winter.

Those who enjoy strolling through a pine forest will feel equally at home in a western forest of Douglas fir (*Pseudotsuga taxifolia*), which is not a true fir despite its name. On the moist Pacific slopes these trees grow tall and straight to a height of 250 feet. They furnish more than a fourth of the saw timber cut annually in America—twice as much as any other species. Only a coastal redwood or a sequoia of the Sierra Nevada contains a bulk of wood greater than that of a big Douglas fir. On this tree, each needle is flat and arises separately on a short stalk. The reddish cones, two to three inches long, have a distinctive thin bract with three projecting points accompanying each cone scale—a positive identifying characteristic of the species.

One could make a comfortable bed of boughs from a young Douglas fir or from a pine. But for a fragrant, needle-stuffed pillow, the choice should always be true fir—never spruce. True firs (*Abies*) and spruces (*Picea*) are "look-alikes," with a similarly conical form while young. They commonly grow in mixed stands. But fir needles are soft and rounded at the end, whereas those of spruce are stiff and sharp. Fir needles are too flat to roll easily between finger and thumb, while those of spruce are four-sided and roll readily. On a fir, the needles are attached broadly to the stem; when they fall off, they leave slightly depressed oval scars. Their cones remain upright, and disintegrate in place after the seeds ripen. Spruce needles are borne on small woody pegs that make the stem rough after the needles drop. The cones are pendent, and remain whole after the seeds fall out, at which time they tumble to the ground.

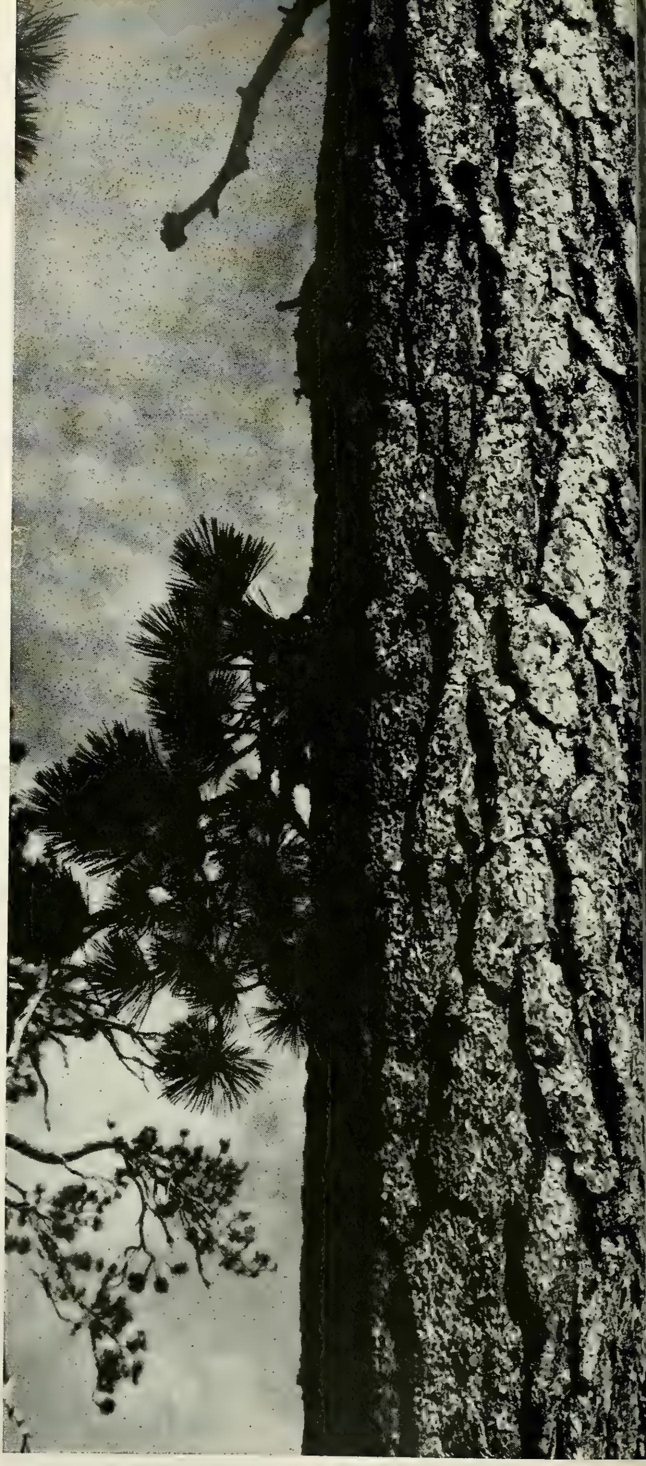
Firs are preferred for Christmas trees, whether the Siberian fir (*Abies sibirica*) of forests across Eurasia or the balsam fir (*A. balsamea*) of the American north woods. Almost a third of the 25 million young trees cut annually for the holiday season in North America are balsam fir, so named for the conspicuous blisters filled with resin ("Canada balsam") on its bark. Young Douglas fir ranks second as a Christmas tree, followed by other kinds of fir and spruce.

Spruces supply most of the pulpwood for the paper industry. One not used in paper production, however, is the Yeddo spruce (*Picea jezoensis*) of Manchuria and Japan, often grown in a pot and dwarfed artificially to become an artistic bonsai.

In the mixed woodlands of the American northeast, one of the most common evergreens is the hemlock (*Tsuga canadensis*), another member of the pine family. Old trees rise only 60 to 70 feet. Their sturdy trunks first attract boring insects and then woodpeckers. The big pileated woodpeckers thrive, in fact, where old hemlocks are numerous and where mature white pines are common. Working in winter and summer on the evergreens, the birds cut rectangular pits—as much as ten inches high and five inches wide and deep—to reach the insects, or they hollow out nest cavities in the dead heartwood.

Old hemlocks, unlike other members of the pine family, often retain low, green-needled branches within easy reach. Along the two sides of each twig, flat needles spread delicately, letting dry snow sift easily between them. Each needle narrows to a short, slender stalk, where it is attached to a small rounded woody cushion of the stem.

Individual needles are inconspicuous on evergreens of the cypress family, for they are small, scalelike, or prickly, arising in pairs or whorls and overlapping enough to conceal the young stems altogether. We see fuzzy branch silhouettes, rather than single needles, when we walk among the windswept Monterey cypresses



(*Cupressus macrocarpa*) of the California coast, or notice the reputedly weeping cypress (*C. funebris*) of China, which has been planted as an ornamental in the Western world. On any true cypress, the needles are only about a sixteenth of an inch long, blunt, and dark green; the hard cones are almost spherical.

The soft and pale evergreen leaves of arborvitae, "tree-of-life" (*Thuja*), overlap and press together tightly so that this member of the cypress family appears to bear flattened branches without foliage of any kind. Our native eastern North American arborvitae (*T. occidentalis*), is known as white cedar. The giant arborvitae (*T. plicata*) of the Pacific Northwest, is often called western red cedar. This tree attains a height of 200 feet and is the principal source of wooden shingles.

In old pastures and second-growth woodlands of the northeast we find the eastern red cedar. The half-inch hard knobs on the branches of this tree are not cones, but galls caused by a parasitic fungus. After a summer rain these galls extend long, soft, orange fingers from which the wind picks up spores. Since the spores infect apples and cause apple rust, eastern red cedars are usually eradicated by orchard growers.

Neither white nor red cedar is a true cedar of the genus *Cedrus,* a genus that includes only four species. Nevertheless, due to errors in early naming of these trees, the common names of several noncedars include the term "cedar."

Actually, eastern red cedar is a juniper (*Juniperus virginiana*), belonging to a genus of the cypress family in which the seeds are borne in fleshy cones instead of hard, dry ones. Known as juniper berries, these fruitlike "cones" are spherical, less than a quarter of an inch in diameter, blue-black, and coated with a gray or pale blue waxy bloom. An extract from the pulp is used to flavor

Ponderosa pine at left. American wintergreen, or teaberry, below.

gin. Fruit-eating birds seek out juniper berries, swallow them whole, and later drop the indigestible seeds. This explains in part why the common juniper (*J. communis*) is found on all sides of the North Pole, as one of the few trees native to both the Old World and the New.

The resinous odors of evergreens appeal to our sense of smell as a fresh and clean fragrance. Cedar oils, distilled from the wood and leaves of red cedar trees, are added to many household polishes. Yet the commercial use of the word *cedar* has come to signify only that a tree has aromatic wood. Cedar wood for chests, closet linings, and cigar boxes comes from a flowering tree of the mahogany family, native to the West Indies.

Japanese cedar (*Cryptomeria japonica*) is a conifer with hard cones. In addition to furnishing valuable timber for use in the Orient, it is carved into ornaments seen all over the world. Particularly attractive are the grotesque frogs and turtles in various sizes, with the design emphasized by the coarse, alternately dark- and pale-brown grain of the wood. The tree itself seems to have evolved in Japan and in adjacent China, and lives only in that region. The bald cypresses (*Taxodium*) and the *Sequoias*, which belong to the same family, Taxodiaceae, are equally limited in distribution today, and are generally regarded as endangered species.

The wonderful *Sequoias*, which include the tallest living trees, the coastal redwoods, were given the name of a Cherokee Indian who promoted the culture of his tribe by devising an alphabet (and who, to the best of our knowledge, never laid eyes on his evergreen namesake). The coastal redwoods (*Sequoia sempervirens*), grow in a foggy belt nearly 500 miles long, which parallels the Pacific coast, but rarely extends inland more than 35 miles. The tallest known redwood was discovered in 1964. It measured 368 feet tall and was nearly 21 feet in diameter at the height of a man's shoulder. It seems incongruous that so tremendous a tree should have needles less than one inch long, as well as cones of similar dimensions.

A mature redwood forest may be parklike, with broad, mossy, fern-covered avenues between the enormous trunks, dimly lit by slanting shafts of sunlight entering through momentary windows in the canopy high overhead. Or it may become unbelievably dense because these trees send up sprouts from their roots that form additional trees. An acre of redwood forest offers more cubic feet of lumber than any other. The wood is weak, but remarkably resistant to decay in humid air. Its popularity for construction work has led to exploitation at a rate that may leave no virgin redwood groves by the end of the present century, except those in national and state parks. Recently commercial operators have speeded up their cutting of trees 500 to 1,000 years old, to prevent their inclusion in untouchable sanctuaries.

The big tree, or giant sequoia (*Sequoia gigantea*, now often placed in a separate genus, *Sequoiadendron*) has a trunk as much as 25 feet in diameter, but is no more than 325 feet tall. Its egg-shaped cones are two to three times as large as those of the redwood, but its needles are shorter and more pointed, unlike those that give a redwood branch its feathery appearance. The bark of a big tree is as much as two feet thick. The heartwood of these trees generally decays, making estimates of their maximum age uncertain. A range of 2,500 to 3,000 years seems reasonable for trees that are still producing an annual crop of seeds. Only a few dozen groves of the giants remain, however. Most of these are in protected parks on the western slopes of the Sierra Nevada in California, at elevations of 5,000 to 8,400 feet.

Trees of such outstanding longevity change little over the millennia. Five or ten generations of giant sequoias could reach back to the end of the Ice Ages; 70 to 100 generations would antedate man's beginnings. Like man, they outlived the impact of the spreading glaciers. Now they are challenged to survive with man in a world far different from the one in which they made their beginnings.

Longleaf pine.

SKY REPORTER

PULSAR WITH A PLANET Systematic variations in the arrival time of radio bursts from a pulsar have been detected, leading to speculation that a planet circling the pulsar may be causing it to wobble in its path.

A team at the Arecibo Observatory in Puerto Rico found a three-month period in the variations of the pulsar NP 0532 in the Crab Nebula. Allowing for everything from the earth's motion to the known rate at which the pulse period is changing, the astronomers found the arrival times varied by 600 microseconds in a pattern that repeated itself every three months. Such a variation could occur if the pulsar were weaving in its path, alternately moving closer to and farther from the earth. The proper wobble would be induced in the pulsar, they calculated, by a planet at least one-tenth as massive as the earth circling the pulsar at about the same distance as Mercury from the sun.

NAKED-EYE COMET During January a comet that is expected to be as bright as third magnitude—easily visible to the naked eye—will come into the view of Northern Hemisphere observers only after it has begun to dim toward the end of the month. But calculations made last October indicate that it may still be a naked-eye object when it climbs over the southern horizon, and it certainly will be visible in binoculars and small telescopes.

Called Tago-Sato-Kosaka for its three Japanese discoverers, the comet was the seventh of 1969. When first seen on October 10 in eastern Ophiuchus, north of Antares, the comet was a diffuse object of 10th magnitude. By mid-November it was moving rapidly south toward Scorpius. The comet's orbit was inclined about 78 degrees to the ecliptic, and it was expected to circle the southern half of the celestial sphere in nearly a north-south direction before reappearing in northern skies.

At least one subsequent comet was discovered in 1969. The Central Bureau for Astronomical Telegrams received a delayed report from Soviet astronomers of a 12th magnitude comet found in Leo last September. Although Russians have codiscovered comets over the years, this was the first all-Russian discovery since 1927.

A DECADE OF QUASARS Ten years have passed since the first quasar was discovered by identifying a radio source with a wispy, starlike object of 16th magnitude on a photographic plate. Lately overshadowed in the scientific and public press by newer discoveries, such as pulsars, the quasars remain a mystery whose existence has revealed entirely new classes of physical phenomena and whose solution will unravel some long-standing cosmological knots.

The word *quasar* originally meant quasi-stellar radio source, but its meaning has been broadened to include radio-quiet, quasi-stellar objects as well. Recent revi define quasars as starlike objects, often identified w small-diameter radio sources, whose light is strong in the ultraviolet, whose radiation at both optical a radio wavelengths is variable, and whose spectra sh large red shifts that ordinarily would indicate gr distances, great velocities, and great age.

Quasars are also numerous; most writers agree t at least a million are visible from earth. If quasars a active only for a relatively short time, as many belie then the total number of live and "dead" quasars m be more like a hundred billion.

Beyond these descriptive facts few astronomers a willing to go very far. Speculation continues, but t pace of quasar work slowed perceptibly in the la 1960's, partly because of the attraction of newer d coveries but also because many lines of quasar wo had exhausted the available information.

After ten years, for example, astronomers are not su whether quasars are the billions of light-years dista indicated by their red shifts or whether they are rel tively nearby objects whose spectral lines are red-shifte by the Doppler effect or by gravitation.

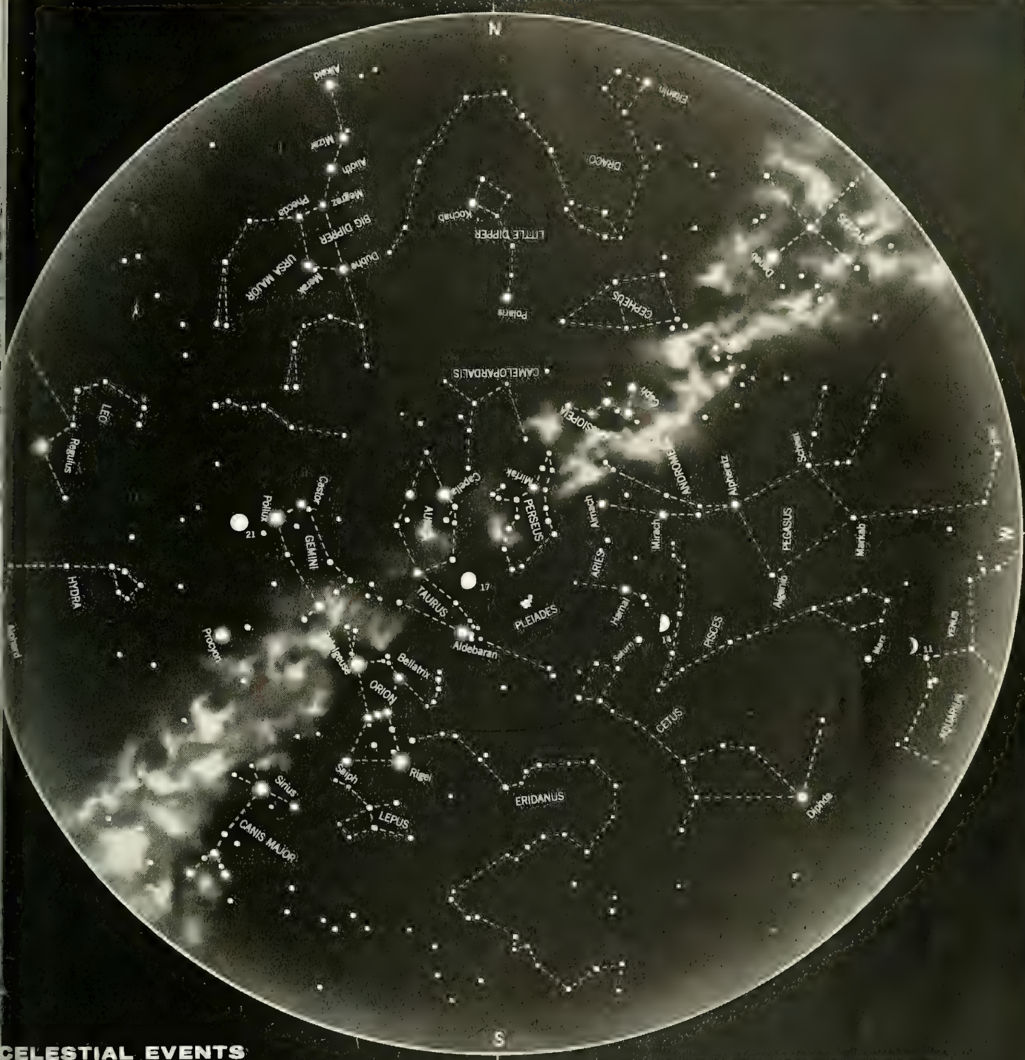
Why the interest? Quasars generate enormous quar tities of energy in very small volumes. Not much large than a single star, a quasar may generate energy com parable to that of a galaxy—a hundred billion stars Astronomers are sure they are watching something the have never seen before.

As the anniversary of the first quasar discovery come up, Geoffrey R. and E. Margaret Burbidge, a husban and wife team that has made both theoretical and ob servational contributions to quasar study, summarize the current situation in *Nature*, the British journal From a welter of observations and conflicting theories they were able to draw the few conclusions that have met general acceptance.

The quasars are not, after all, a totally isolated phenomenon. Rather they appear to be related to the Seyfert and radio galaxies, characterized by ultra-active nuclei. One may be the first step in the evolution of the other. The Burbidges say, "There is clearly a period in the history of a galaxy or a compact superstar when it releases nonthermal energy in huge amounts, giving rise to optical flux, infrared radiation and radio flux, and excites large amounts of gas."

They also find it becoming clear that these "compact masses" are somehow releasing gravitational energy. Agreement ends at the question of how the energy is released. Stellar collisions, frequent supernova explosions, and gravitational collapse all have been offered as possibilities, but the Burbidges report that none has found general favor. None is able to explain, for example, how any of these processes could result in the ejection of coherent clouds of ionized gas, a process almost certainly going on.

JOHN P. WILEY, JR.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CELESTIAL EVENTS

The moon is in the morning sky until new moon on the 7th, then enters the evening sky. First-quarter is on the 14th and full moon on the 22nd. Again in the morning sky at month's end, last-quarter moon is on the 30th.

Mercury and Venus are too close to the sun to be observed in January. Mars and Saturn are evening stars, both setting by midnight, and Jupiter is a morning star, rising after midnight.

January 1: Earth is at perihelion—nearest the sun—at a distance of about 91,450,000 miles.

January 2: Two bright objects near the crescent moon this morning are Jupiter and Spica. Jupiter, the brighter, is to the east (left) of the moon, and Spica, in Virgo, is to the west (right).

January 3: Mercury is stationary and begins its retrograde (westward) motion.

January 4: Saturn resumes direct (eastward) motion in Pisces.

January 8: Expect higher high tides with the new moon close to perigee.

January 11: Mars is to the left of the waxing crescent moon tonight.

January 13: Mercury is at inferior conjunction and enters the evening sky.

January 24: Mercury resumes direct (eastward) motion. Venus passes beyond the sun at superior conjunction and enters the evening sky. The star close to the moon tonight is Regulus, in Leo.

January 30: Jupiter rises near the last-quarter moon in the morning sky.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 9:15 P.M. on January 1; 8:20 P.M. on the 15th; and 7:20 P.M. on the 30th; but it may be used for about an hour before and after those times.

WEANING GRIZZLY BEARS

A report on *Ursus arctos horribilis*

by A. Starker Leopold

On the night of August 13, 1967, two young women were killed by grizzly bears at widely separated localities in Glacier National Park, Montana. Although these fatalities were the first attributed to grizzlies in the U.S. national parks since 1916 (these animals generally keep their distance from human beings), the Glacier incident provoked articles in popular publications asserting that parks should be "made safe for people" by eliminating the bears.

This proposed solution, however, lacks both objectivity and sophistication, to say nothing of sensitivity. Still, authorities responsible for the welfare of both men and bears in the National Park System have been stimulated to reconsider the grizzly's status and habits, and the natur
its encounters with people, so
steps can be taken to minimize
eliminate the tragic type of event
occurred in 1967, yet insure the
tinued survival of this rare anima

The grizzly bear (*Ursus arctos*
the largest and potentially most d
gerous carnivore native to conti
tal North America. It occurs in
sorted sizes, from the giant br
bear of coastal Alaska (1,500 pou
or more) to the modest-sized M
can grizzly of the Sierra Mac
which generally weighs from 28
500 pounds. All grizzly populati
seem to thrive best in wilderness si
ations far from human habitati
The majority of the grizzly bears
maining in North America oc
mostly in the wilder parts of Ala
and in the Canadian Rockies. As lo
as wilderness haunts persist, the b
will have a home in the northweste
quarter of the continent and w
probably escape extinction.

The most acute problem of griz
conservation exists in the weste
half of the contiguous United Sta
and in adjoining parts of Mexi

where the animal is now generally nown as *Ursus arctos horribilis*), lue to the presence of growing hunan population in these regions. The rizzlies once ranged from the Great lains to the Pacific Ocean. They avored the foothills, brushlands, and iver valleys, rather than the high nountains. Thus it was that Lewis nd Clark first encountered the great white bear" along the river ottoms of the Missouri. Similarly n California, the central valley of the acramento and San Joaquin rivers nd the attendant bottomland hickets of valley oak and tule atches were prime grizzly range ntil late in the nineteenth century. n these situations travelers and later ettlers had more frequent contact vith the grizzly by virtue of its occuation of the bottomland, than they ad with the black bears (*Ursus mericanus*), which tended to frequent the mountains. Human settlement in the western United States led o the rapid extermination of grizlies over most of the native range.

The last general review of the rizzly population of the United States was made in 1956 by R. F. Cooney, then with the Montana Game Department. He estimated the population in Idaho at 60 animals; in Wyoming (exclusive of Yellowstone National Park) at less than 50; and in Montana at 450 (excluding Glacier National Park). Recent estimates of the park populations indicate that there are 200 to 250 in Yellowstone and 170 to 180 in Glacier —the only two national parks that still retain populations of grizzly bears. Cooney thought that there might be a few of the big bears left in the states of Washington and Colorado, although there is no recent evidence from either state to support this. The total grizzly population remaining in the western United States is, therefore, less than 1,000 individuals. In recognition of this marginal status, the Bureau of Sport Fisheries and Wildlife in 1966 officially designated the grizzly bear a rare and endangered species.

In Mexico, the status of the grizzly bear is even more precarious. The species originally was known in five of the northern states: Coahuila, Durango, Chihuahua, Sonora, and Baja California. Exploitation of the mountain areas by logging, mining, and grazing led to persecution and extinction of these animals, just as it did in the western United States. In the 1950's a remnant population of grizzlies was found to persist in the Sierra del Nido—a small, isolated range emerging from the desert of central Chihuahua, just west of the Pan-American Highway. Following this discovery, the Mexican wildlife authorities promptly placed the grizzly on the list of protected species. At the same time the Sierra del Nido came under intensive study by field parties from the Museum of Vertebrate Zoology at the University of California. It was hoped that the whole mountain range might ultimately be dedicated as a National Wildlife Refuge by the Mexican government, and a biological survey of the area was undertaken. But even as the survey progressed in the early 1960's, the grizzlies disappeared. One old bear—a large male, whose rear track allegedly measured 16 inches—made the mistake of killing

an Angus bull on a ranch owned by a "progressive" and determined businessman from Juarez. This rancher then declared all-out war on bears, distributing poison baits liberally over the range. By 1968 no trace of a living grizzly remained.

This seemed to mark the end of the Mexican grizzly, a distinctive and unique subspecies of the "silvertip" as the grizzly is sometimes called. But in 1969, a cattle rancher from the upper Yaqui Basin of Sonora, reported the continued presence of grizzlies in the vicinity of his holdings, situated along the crest of the Sierra Madre some 100 miles west of the Sierra del Nido. This rancher (Mr. Ben Tinker) has made a general policy of protecting the grizzly bears in the vicinity of his ranch. Field surveys of this area are contemplated in 1970 by personnel of the University of California. Based on Mr Tinker's accounting, the grizzly is holding its own—with a population of several dozen animals—in the rough country of the upper Yaqui Basin, so perhaps there still remains a chance to protect and restore a representative sample of the Mexican subspecies.

The population of grizzlies inhabiting Yellowstone and Glacier National Parks constitutes almost half of the total population of the species in the United States and Mexico. These bears are the most secure from either hunting or habitat destruction, and it is within the parks that men and grizzlies come into most frequent contact.

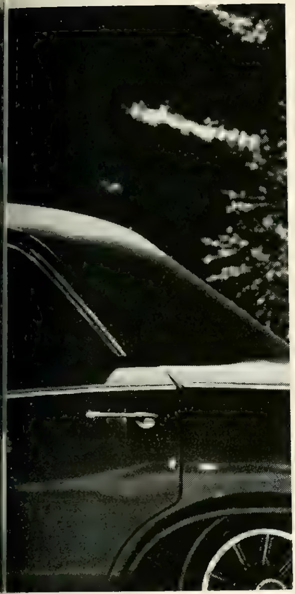
After Yellowstone National Park was established in 1872 and long before Glacier Park came into being, the northern Rocky Mountains were being hunted by commercial market shooters. Much of the wildlife in the vicinity of Yellowstone, for example, was killed during the era of railroad construction. Hunting in Yellowstone was not specifically prohibited until 1887. Thereafter, regulation of poaching was inadequate, but on the whole the various kinds of native wildlife began to recover, and during the 1890's there was definite evidence of rehabilitation in game numbers. In the park, both the grizzly bear and the black bear increased irregularly from the 1890's, when protection became effective, until perhaps the 1950's, when the population stabilized at levels of about 200 and 500, respectively. Probably these are the maximum numbers of bears that can be supported by the available food and space within the park.

One factor that may have had some bearing on the increase in bear numbers was the dumping of refuse and garbage by tourist hotels, which had become well established in Yellowstone in the 1890's and somewhat later at Glacier. This attracted the bears, and made bear watching at the garbage areas a popular form of tourist entertainment that was looked upon as an important element of "wildlife management" by park administrators of that era. In 1919 garbage dumping was augmented by the establishment of definite feeding stations for bears at popular points in Yellowstone. Visitors thereby were given the opportunity to observe and even photograph the animals close to the resort hotels. It was this background that led to some of today's bear problems.

Whereas both grizzly and black bears in their native wilderness habitats go to some lengths to avoid confrontation with human beings, garbage-fed bears in parks lose thei shyness. Familiarity with peopl seems to lead to a diminution of fea and to an attitude of aggression o the part of the bears. Similarly through their bear-feeding experience, people seem to lose their fea of the ambling and seemingly harmless bears.

Superintendents of Glacier and Yellowstone Parks have long recognized the problems inherent in the close proximity of bears to people. The parks' technique for dealing with troublesome bears has been to trap the individuals and move them as far as possible from the campground or resort area where they were creating a nuisance. If an animal returned and renewed his activities, he was finally destroyed. In Yellowstone annual elimination of chronic offenders now averages 34 black bears and 3 grizzlies per year. In Glacier the control kill averages 7 blacks and 2 grizzlies. But the killing of incorrigible nuisance bears has not of itself proved to be a solution to the problem of bear damage.

In the 1960's the National Park Service reaffirmed the concept that a national park should display native plants and animals in natural settings



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with a minimum of artificiality. There followed a whole sequence of changes in the service's “bear policy.” As applied to black bears, one of the first steps was to discourage visitors from feeding the begging bears at roadsides—a program in which considerable progress has been made throughout the entire park system. In the Great Smoky Mountains, for example, and in some of the national parks in California, the number of begging black bears has been substantially reduced by road patrols that enforce the regulation against handouts. Also, all park visitors are provided with a pamphlet warning of the dangers of this practice. To the extent that this policy is successful young cubs do not learn the fine points of panhandling, but rather have to get out in the woods with their mothers and search for natural food sources. In both Yellowstone and Glacier Parks, this anti-bear-feeding policy has brought a noticeable change in the behavior of the black bear population, and the numbers of these animals that have had to be removed because of danger to tourists has been reduced.

A second element of the bear program, which has affected both blacks and grizzlies, is the installation of bearproof trash cans throughout the parks, especially in and around campgrounds. These are mounted on stout steel posts set in concrete. The can has a swinging door at the top designed to prevent pilfering and is attached to the post by a circular bracket that prevents the bear from tipping the container over. Few bears learn to extract items from these cans.

Bearproof cans are expensive, however. It took a number of years before Park Service budgets could absorb the conversion from the old trash pails to these new containers. Today, conversion has been completed in several national parks, including Glacier and Yellowstone.

A third change affecting bears will be the elimination of garbage dumps and open trash pits. The two bears that caused fatalities on that unhappy night in 1967 had both been accustomed to feeding at garbage dumps or campsites; moreover one of them had reportedly been receiving food handouts in the vicinity of a nearby tourist lodge so that visitors could observe him. Apparently, both bears had lost their fear of men and had become somewhat belligerent. In Glacier National Park, refuse pits are now covered daily with a layer of earth and the bears are re-

capturing their wild patterns of behavior, abandoning the dumps to search the forests for natural food.

In the case of Yellowstone National Park, first steps have been taken to eliminate grizzly feeding at the major dumps. The Trout Creek dump, in the center of the park, has been equipped with an incinerator, and the trash is now sorted so that burnables—including discarded food items on which bears feed—go to the incinerator. But while grizzly attendance dropped off at Trout Creek dump, visits to other nearby dumps increased during the summer of 1969. This problem will not be solved overnight. Bears, conditioned by years of human handouts, can hardly be expected to abandon their old habits on command.

The question of what to do next was discussed at a meeting called by the National Park Service at Yellowstone in early September, 1969. The meeting was attended by administrators and biologists of the Park Service, by the Natural Sciences Advisory Committee appointed by the director of the Park Service, and by several outside experts who have done extensive research on grizzly bears. Out of this meeting came recommendations that, hopefully, will be useful in coping with grizzlies in Yellowstone and other applicable locations. In general, the conferees agreed that the object of park bear policy should be one of minimizing dangerous man/bear encounters, while continuing to maintain a bear population commensurate with the park's capacity to provide these animals with the space and natural food supply they require in order to retain their natural life styles.

Again, the primary management technique for achieving this goal will be to deny bears access to unnatural food sources. The park will expand its efforts to remove edible rubbish, eventually hauling it outside park boundaries and burning it in areas not frequented by bears. The most apparent danger in removing trash heaps is that the hungry bears, failing to find anything to eat in the old garbage pits, may wander into the campgrounds. The program, therefore, must stress campground protection practices that will keep grizzly bears away from heavily used camp areas.

One step in this program would educate the public in proper tra disposal and safe storage of food su plies for the night so that bears cou not find contraband while wanderi through the camps. Another wou strengthen the night patrol of cam grounds by trained and equippe men who could keep track of th movements of grizzlies near and i campgrounds and either herd the

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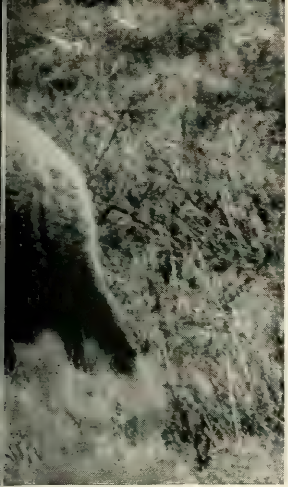

"... grizzly populations seem to thrive best... far from human habitation."

t or, if necessary, capture them for moval. Scare devices, bearproof ncing, and other practices to dis-urage bear intrusion are also being udied.

It may be that during this interim riod when bears are relearning the t of living off the wild landscape, me of the campgrounds within the ntral portions of Yellowstone—where most grizzlies are found—may have to be closed to insure the safety of visitors. Ultimately, some of the campgrounds may even require relocation if they are badly situated in terms of intercepting normal grizzly traffic. After Yellowstone bears have been successfully "weaned" from human dependence, it is hoped that their natural shyness will make them avoid further contact with humans.

In both Glacier and Yellowstone National Parks all meetings between bears and people are now recorded on maps, in order to determine regular patterns in the time and places when contact is most likely to occur. For example, in Glacier National Park where there is considerable hiking by visitors, it has been found that the grizzly bears generally frequent valleys (rather than mountainsides) early in the tourist season. Also, bears emerging from their winter sleep in May or June are hungry and grouchy and frequently express themselves in aggressive ways when they meet hikers on the trail. Later in the season the grizzlies are better fed and their dispositions improve considerably. Moreover they tend to move higher up the mountains, following the crops of huckleberries and other natural foods. The park administration now furnishes hikers and campers with this information and may even adopt regulations concerning foot traffic by tourists, which will tend to direct people away from the areas being used by grizzlies.

Certainly, none of these steps rep-

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resents a "breakthrough" in the handling of relationships between bears and men. They have worked in the past, though, and with more extensive and intensive application will probably produce favorable results when applied over a period of years.

Perhaps as a result of the unfavorable, and sometimes spectacular, media coverage given this issue, the National Park Service has come under fire to "do something about the grizzly problem." In this regard, it should be recalled that such a "solution" is dependent upon the often unpredictable behavior of both bears and men, and that in most past cases, bear "incidents" could have been prevented with a little human forethought.

Forethought, and forewarning, undoubtedly are responsibilities of the Park Service. Statistically, most incidents resulted from the carelessness of a park visitor who had already been cautioned about bear safety, about exiting from an auto in the presence of bears, about hand feeding the animals, and so on. Then too, the limited personnel and financial resources of the Park Service become significant in relation to bear management. It is extremely expensive and time-consuming to dispose of the rubbish created by 25,000 daily visitors at Yellowstone National Park, for instance, and to patrol against both inadvertent and intentional bear-feeding practices on the part of that many people.

Outside the borders of Glacier and Yellowstone National Parks, most grizzly bears live in national forests, particularly in designated wilderness areas. Most of this population occurs in the state of Montana, with relatively modest numbers in Wyoming and Idaho. Unlike the park populations, the animals in national forests are subject to legal hunting according to the regulations of state game departments.

Many grizzly bears outside parks have had some experience with hunters and tend to be wary; they are not often seen by casual visitors. Some of the bears that appear in areas open for hunting spend parts of the year inside the parks. This has been ascertained by Frank and John Craighead, who have done considerable research on the movements of marked bears. Regulation of hunting in the wilderness country surrounding a national park will, theref have some relevance to the statu the park population of bears.

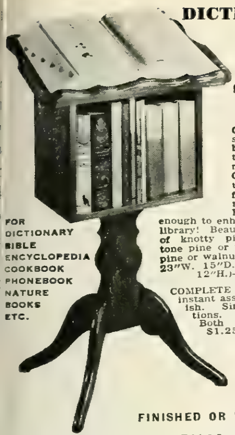
The numbers of grizzly bears so modest in Montana, Wyomi and Idaho that sport hunting, w it is permitted at all, should be loo upon as a special privilege. Wher bear-hunting regulations in Ala and western Canada are quite ger ous in terms of seasons and numb of animals killed, regulations in northern Rocky Mountain sta should be always on the conservat side.

There is, of course, considera interest in grizzly hunting on the p of the guides and packers who ma their living by attracting hunters w hope to bag a rare trophy. Yet t continued survival of the bear mains questionable and the actu number of animals taken throu hunting should be held to a mi mum, even if there is some mode increase in the number of grizzli

In addition to protecting the be population outside the parks fro excessive hunting, it is equally i portant that the major wilderne area in which the grizzlies live rigidly protected from penetratio by roads, jeeps, motorized vehicle airplanes, and other mechanical aid Contrary to popular opinion, prese vation of the wilderness habitat probably an even more importa aspect of grizzly protection than the curtailment of hunting.

One possible technique that ha not yet been fully studied is that o capturing and transplanting grizzl bears from existing stocks, as fo example in the national parks, t areas where the species has disap peared. One area in which grizzlie might be restocked is the high moun tains of southwestern Colorado where grizzlies persisted until the las decade. Too late the Colorado De partment of Fish and Game, along with the U.S. Forest Service, tried to protect the last bears in this region from eradication, largely by sheepherders, but seemingly those efforts were in vain.

It is possible that some of the bears brought from elsewhere and liberated in a new environment could wander onto ranch lands where they might kill or frighten domestic livestock. Perhaps some of these would have to be destroyed. Judging from grizzly behavior in large stretches



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of wilderness, however, most bears would adapt to the environment by using natural food sources, and would cause ranchers little trouble.

Many mountain areas that have been intensively developed for general recreation and hiking might best be left without grizzlies. The Sierra Nevada of southern and central California would be an example of an area too intensively used to be able to support grizzlies in isolation from people. On the other hand, there are many forests and wild mountain regions within the western United States that could potentially be stocked. This possibility deserves the most careful study by research workers and government agencies. The security of the grizzly as a species would certainly be strengthened if new populations could be established, far from the existing stocks.

The grizzlies adapted to the most southwesterly portion of the species' original range, such as those in Mexico's Yaqui Basin, are a rare genetic strain and should be strictly protected and saved if at all possible. The first step on this path is to study the distribution of the bears in the field and to estimate the population. Then a program to preserve a viable population of the big bears could be worked out with local ranchers and residents. The Mexican government should be encouraged to establish an adequate refuge designed to assure the security of a population of Mexican grizzlies, as was planned in the past. This refuge could be in the Yaqui region, or possibly in some other area of Mexico that might be more available or more suitable. The chief of the Mexican Game Department, Senor Rudolfo Hernandez Corzo, has expressed considerable interest in the preservation of the grizzly within his country, and the portents for developing an effective program there are good.

None of these plans are panaceas for the species' ills; neither are they guarantees that there will be no destructive encounters between that species and our own. Still, rapid and determined steps are needed if we hope to protect the 1,000 or so of these wild and magnificent animals that persist south of the Canadian border. At this point, these protective moves represent the best and most civilized action that we can take.

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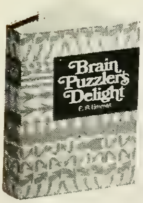

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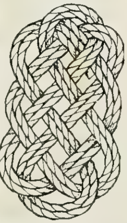

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The Island Earth *Continued from page 22*

With this new realization, which is expressing itself in a hundred different ways, from government commissions and antipollution groups, to the American Association for the Advancement of Science's Committee on Science in the Promotion of Human Welfare, to the Scientists Institute for Public Information, to small committees in small New England towns, the debate goes on. (A large number of these new movements were discussed in "The New Conservation," by Richard L. Means, NATURAL HISTORY, August-September, 1969.) With this proliferation of public interest, those who have been fighting these battles for conservation, for protection, for soil rehabilitation, for reforestation, and those who have become more recently aware of the dangers of pollution, overpopulation, and overload of every facility are meeting and looking for new ways of stating their common interests. Words like *ecosystem*, the whole interacting system in which a change in any one variable —temperature, the number of fish or of fishermen, a factory built on the banks of a stream, or a florist's seed field five miles away—may change the whole system, and *biosphere*, the whole natural living system of the planet and its surrounding atmosphere, are coming into the vocabulary of the concerned all over the world. These terms come from the science of ecology, a science that, on the whole, took as its model a pond, a lake, or a marsh and, while allowing for interaction among every natural component, took little cognizance of man himself, except as an interfering factor. If we wanted to teach our children about ecosystems, the model we used was an aquarium, in which the delicate relationships between water, plants, and aquatic creatures had to be watched over and kept in balance.

Aquariums are indeed a fine teaching aid and will give children an idea of the balance of the natural world, especially the great mass of urban children who meet nature either in the form of a pet who has to be walked in the streets or provided with "kitty litter." But it is becoming increasingly clear that this model, over which the aquarium owner stands, like a god, presiding over a small glass tank heated b electricity (itself vulnerable to power failure) is only a very parti model of what is happening to u The child's aquarium is a model of world almost totally dependent o man, but of which he is a spectato and protector, not an integral par

If, from the science of ecology we try to develop a new professio of those who stand guard over th environment, we stand in danger o still leaving man outside, to becom an "environmental manager," a significant factor, but not a true part o the natural world. To the core subjec of ecology, it is suggested that we ad the human sciences to train aspiran young environmental managers t deal with the problem. As new subject matters develop in the field o urbanization—ekistics, urban planning, urban design—there is an attempt to patch together from a number of disciplines a new whole, a science of the total ecosystem, into which man, somewhat grudgingly, is to be admitted.

I do not think this is the way to do it. We have had many decades of various interdisciplinary projects. Either they represent a coalition of different disciplinary interests, in which each defends his own territory, or we get new incorporative fields, like economics or public health, which manufacture their own psychology and educational theory to suit themselves and, in turn, become little empires defending their domains against contenders.

I believe that there is another way to develop the kind of specialists that we will need as public concern for our endangered planet and for our starving millions mounts. And this is where islands come back again. What students need to learn if they are to think about environmental protection and development is about whole inhabited ecosystems: ecosystems in which man himself, the way he plants and reaps and disposes of waste, multiplies or stabilizes his population, is a *conscious* factor. Man has molded and changed his environment since he learned to make tools and control fire. But in those days, perhaps a million years ago, he was not conscious of what he did, of how population was related to food supply, of w killing the young or eating all eggs or gathering plants before y seeded would limit his future. It s on islands that man first began to rn these things. If there were too ny people, either some would be iven out into the uncharted seas there would be civil war. Some thod of population control had to adopted. Younger sons were forlden to marry and infants exposed die. Islanders knew when the birds me to nest, when the fish came to awn, how periodic hurricanes afted their harvests. On many small ands today, the harsh realities of apidly changing world are forcing e men away to work, leaving only men and children at home. It was islands that men first learned that ey themselves were part of an ecostem, so it is perhaps not surprising at the religious system of the annt Polynesians emphasized taboo, at things were forbidden in the ture of the system itself. Under boo, if men made no missteps they ed safely, but they had to be conuously alert to the consequences infringement of the order of nare and the order of social life.

We need to find ways to undernd, to teach children, and to prere young men and women for reers in our interconnected and dangered world. The forces of pub opinion are being marshalled nanally and internationally. A great ternational conference, conspicuis for its level of cooperation nong usually rivalrous United ations specialized agencies, was ld in Paris in 1968. A conference biology as the history of the future, sponsored by the International nion of Biological Sciences, was ld in Chichén Itzá, Mexico, in nuary, 1969. At the initiative of veden, a great United Nations conrence is being prepared for 1972. e need to have a model that will ake man—always active, seldom nscious, irresponsible throughout ost of history—a conscious particint in the development of planet arth.

The smallest islands of the earth e almost all in trouble, whether it the islands of the Hebrides, fightg the British Parliament and payg no income taxes; the burgeoning pulation of Mauritius; the belligerent population of Anguilla; or the small Greek islands whose men must all go away to sea. Such islands, grievously resourceless, overpopulated, and dependent upon distant and outside money, can become our models and our training grounds for the new professions that are needed. As small children were once asked to build a model of Solomon's Temple in Sunday School, or of Egyptian pyramids in day school to understand ancient civilizations centered on man alone and reflecting his natural environment, we now need materials so that each child in a class may have an island to think about: its size, its shape, its location, its weather, its resources, the habits and skills and despairs and hopes of its inhabitants, and its dependence upon world markets and diplomatic decisions in which its people have no part. And for those older students who wish to make a career of the protection and development of the whole of man's environment, a year on an island, learning the language, mastering the intricacies of the interrelationships of its living population and all its plants and creatures, would be perfect preparation for thinking about wholes. We would not need to patch disciplines together in an uneasy truce; members of various specialized disciplines could first obtain a firm grounding in their own fields and then—with a year's field work on an island—learn to articulate that speciality into a whole.

Following in Darwin's footsteps, Harold Coolidge began the trek back to islands for inspiration when he took a whole group of scientists to Galápagos in January, 1964. But the Galápagos have no human beings on them. It is the inclusion of people and their purposes that is now our problem. Nor need we ask islands—often in dire straits—to contribute, yet gain nothing from what they teach us about our planet Earth. Each student could be asked to work on some real problem, urgent to the people themselves, and thus prepare himself for the kind of world role when, in the 1970's and 1980's man's survival will hang in the balance—and the generation now growing up will have the task of saving this planet as a habitable spot for their children and their children's children.

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The Return of the Naked Ape

by Robin Fox

The Human Zoo, by Desmond Morris.
McGraw-Hill Book Co., $6.95; 256 pp.

In his previous work of science fiction, Desmond Morris introduced us to *The Naked Ape* (Reviews, Natural History, February, 1968), a species in many ways not unlike our own. His intention was, one presumes, to force us to think about mankind as a biological species by seeing ourselves—the ape in underpants—as closely analogous to the naked variety. The device is not new in fantasy literature. Swift created the Lilliputians who resembled us in everything but stature, and so forced us to take a more objective view of our own idiocies. Similarly, after we had finished laughing at *The Naked Ape*, we had to admit that the animal was sufficiently like us for the joke to be no laughing matter. True, he had not developed much in the way of articulate speech and thought, or what used to be quaintly called the higher faculties, but he was recognizable nonetheless. It was disconcerting to find that his prototype was a kind of suburban commuter, but then, since the author was himself a suburban commuter, he could be excused for writing from his own limited, but interesting, experience.

The moral of *The Naked Ape* was, I think, that we should get to know our biological natures better so that we could tell whether we were blocking them, augmenting them, fulfilling them, or just ignoring them. There were hints that, with the splendid exception of the monogamous, commuting, civilized, north-London suburbanite, we were not doing very well at keeping in touch with biological home base. All preliterate peoples, for example, were dismissed as failures because they no longer "explored their environments," and the "mainstream" or "successful" cultures were held up as true examples of the most basic behavior of the species.

In this sequel—"Return of the Naked Ape"—Morris looks hard at the mainstream and finds that despite its connection with its biological roots, as evidenced by its "success," it is getting out of hand. Thus, for example, the "failures" seem able—even with their bizarre customs, and perhaps because of them—to control their numbers; the "successes," with all their faithfulness to their heritage, can't seem to do so. The failures seem able to run more or less egalitarian social systems, while the successes get all fouled up in the collective hysteria of "superstatus" seeking—and so on. It would seem that being in touch with our biological heritage is a chancy business.

In *The Human Zoo*, Morris neatly reverses his former position. The small groups of hunters and tribesmen are now the natural groups living the natural life; the great urban civilizations are a series of zoos whose incarcerated inhabitants display all the pathologies of captive animals. I tend to like his new position better than his old one, but it does lead him into some curious mental gymnastics.

The basic thesis is not new. Our problems stem from the size and rapid growth of the human population consequent on the development of agriculture and urbanism. A violent change of pace and complexity was introduced fairly recently into the life of an animal evolved to be an efficient, ranging, small-group-living hunter. He has not had time to make genetic changes of any consequence to meet this challenge, so with this primitive evolutionary equipment he must try to survive in complex, urbanized, crowded communities, for which he was not designed either physically, emotionally, or intellectually.

The Human Zoo explores the consequences of this change of gear in seven chapters dealing with nations, status, sex, race, imprinting, stimulation, and education. One way of doing this would have been to note carefully the details of our primate heritage, explore the modifications occasioned by the change to a hunting way of life, and so mov on to the establishment of a base lin of "natural" social behavior for th human species. One could then look a the crowded urban community and se what was pathological about it, and what was not, in terms of the picture of natural conditions. But Morris does not do this, and it is clear that what might have been an interesting theoretical argument is for him only a peg on which to hang anecdotes, obiter dicta, and entertaining analogies.

What are the criteria for distinguishing the natural from the pathological in human behavior? Roughly speaking, Morris suggests that behavior found in zoo animals is pathological, therefore where we find analogies to this in human behavior we can assume it too is pathological. This may well be true—

I doubt it—but in any case it has to be argued and demonstrated. We have to know whether the behavior in question is an aberrant reaction to zoo conditions, an "inbuilt" pathology, or simply part of our "natural" repertoire. Morris's method allows him to condemn as pathological anything he views as unnatural, by citing cases of it in zoos. Sometimes he doesn't bother to do even that. Therefore he can't blame those of us who share his basic *Weltanschauung* from feeling uneasy at his lack of serious argument here. The fact that this is an avowedly "popular" book is no excuse.

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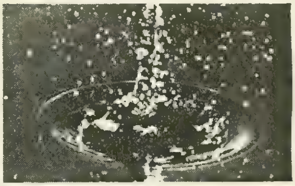

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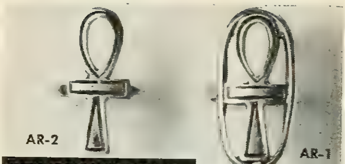
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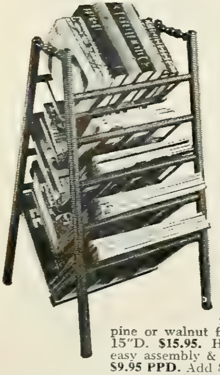
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Clifford A. Pulis, 6 Old Marlboro Rd., Concord, Mass.
EST. 1954

tions for intergroup violence. The last three chapters, while less slick, are, in many ways, more interesting. The chapter on imprinting, for example, attempts to apply this ethological concept to human learning. While it is largely a speculative effort, it does raise some intriguing questions.

The chapter on stimulus struggle is a delightful exercise in ingenuity. One of our biological characteristics is a tendency to seek "optimal" stimulation from the environment. According to Morris, "natural" man had no trouble with this since he was wholly engaged in the business of survival and this took all his time and energy. Yet anyone who knows anything about hunting or tribal societies (these are never defined) will recognize this as a gross caricature. Morris, however, does not feel it necessary to survey the actual expenditure of energy in these societies so that we may see just what amount is given to subsistence activity on the one hand, and to ritual, gambling, sport, art, and recreation on the other. As Morris (a zoologist by profession) said quite openly in *The Naked Ape*, his material on human behavior is anecdotal and is based on casual observation. Apparently Morris does not feel it necessary to undertake careful study of the species he so confidently analyzes. Furthermore, he rarely tries to strengthen his conclusions by using the findings of sociologists or anthropologists who have spent their lives in such study. Is this good zoology? If an anthropologist, on the basis of what he knew about man, analyzed the pathology of the ten-spined stickleback after a few "casual observations," Morris would be rightly outraged. Morris shows no awareness at all of what actually goes on in contemporary hunting societies, or of what went on in paleolithic hunting societies, either of which could have provided him with data on which to establish his base line.

According to Morris, unfortunate "zoo-confined" modern man has a "stimulus problem"—he either gets too much and too confusing stimulation or too little and too boring. In the chapter on the childlike adult, he points out how easily the creativity of childhood can be thwarted by adult demands for order and pleads for a reform of education and town planning in a more "playful," and hence innovative and exploratory, direction.

The aggravations that result from urbanism and population size are most noticeable in the areas of nationalism, sex, and status. Tribes are our natural social units; supertribes present us with problems. The tribe is small and unihierarchical, while the supertribe is large and multihierarchical. With status, the fairly controlled hierar of the small unit becomes the nig mare of superstatus in the nation.

With the discussion of sex we back to some *Naked Ape* themes. seems that criticism of his posit equating pair bonding in animals w falling in love and lifelong monoga in humans has hit home. In the pres book, Morris's views on sex are m complicated—and so are his argume In the earlier work his explanation the awkward fact that, sexually, human pair bond is not uniformly exclusive relationship, was that hu ing conditions evolved the pair bond man, but that it has not had a lo enough evolution to "take" properly, we have problems with it. Note th this makes the tensions between mati bonds and sexual variety inherent. the new version however, pair bondi has been re-established as basic, a failures of the pair bond (the inabil to achieve lifelong, faithful mon amy) are attributed to the pressu of zoo conditions—in particular the d mands of status sex. Thus his way dealing with the criticism that sexu relationships in humans are more co plex than he allowed is to say that t complexities are not inherent, but a pathologies. Again we must ask: h do you establish the "normal" her Simple assertion will not suffice. O posing viewpoints are dismissed saying that they are the rationaliz tions of those people who cann manage their own pair bonds. If Morr wishes to keep the respect of h colleagues as well as the gratitude his publishers, he will have to do bett than this. *Ad hominem* insults are substitute for argument. One could, f instance, trade sneer for sneer by sa ing that only people with exaggerate infantile dependency anxieties wou make a fuss about pair bonding—b to what end?

As always, Morris's writing is ente taining and provocative, witty, and eas to read. Those of us who share his basi orientation are bound to feel ambiv lent about the book since the jury w appeal to—scientific opinion—is certai to be outraged. It is doubtful, howeve if the book will do any harm, for whil it offers no real analysis that migh sway social scientists in a biologic direction, it does raise certain issues i an undemanding way. Those of us wh admire Morris as a zoologist would no like to see him write the serious an important book on human behavior tha he owes us and, more importantly, owe *himself*.

Dr. Robin Fox is a professor i the Department of Anthropology a Rutgers University, New Jersey.

ENOMOUS REPTILES, by Sherman A. inton, Jr. and Madge Rutherford inton. *Charles Scribner's Sons, .95; 274 pp., illus.*

Are you interested in the length of a coral snake's fang, the effect of a snake's bite, or the Pima Indian gend of the first rattlesnake? Or ow about the average length of the ila monster, the lethal venom dose of tiger snake, or the best venom source adenosine triphosphatase? This ook has all of these, and much more esides.

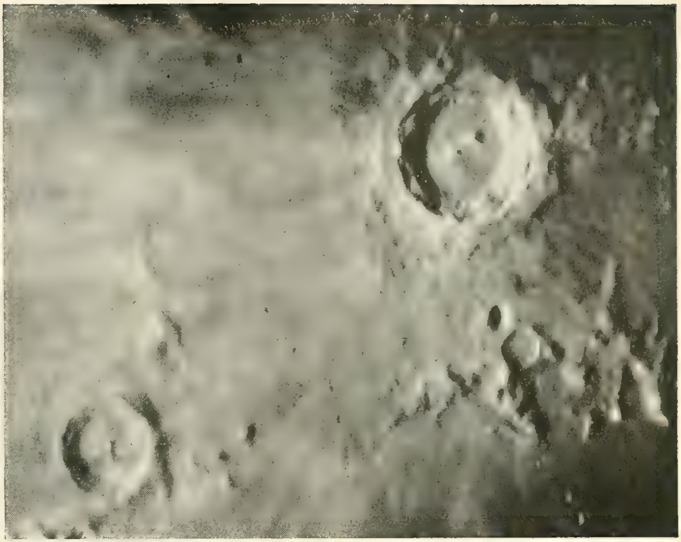
Physician-scholars have always been short supply, and those who are inrested in snakes and venoms can be ounted on the fingers of one hand. Dr. Hinton is one of the few, and we are rtunate that he has turned to a more opular form of writing to offer his nowledge to a wider audience. And Madge, his wife, has followed him in is peregrinations from Indianapolis to arachi, and from Tel Aviv to Tlaxala—lending a hand in collecting, olding snakes for venom extraction, nd now contributing head and hand oward the preparation of this book. Her own studies of the Jogi (snake harmer) tribe of the Sind and her houghts and researches on the roles hat snakes have played in human affairs contribute significantly to the resentation here.

The arrangement of the book is more cholarly than popular. After a short ntroductory chapter on the classificaion, geographic distribution, and evoution of the major venomous reptiles two lizards, all the rest snakes), the ook pitches into a series of chapters n venoms and allied subjects. This liscussion—the clearest I know of the omplexes of venom gland structure, he physiology of venom secretion, the tructure and effects of venoms, snakeite and the philosophy of its treatnent—makes up about half the book.

Following this, the book deals mainy with snake-man relationships. These nclude the myths and legends, both ncient and modern, that have been erpetrated about these creatures in arious parts of the world and their ole in religious thought and presentlay folklore.

The final chapter, "How Snakes Acuired Charisma," explores the strong feelings (claimed by some to be "innate") that snakes have engendered in man throughout the ages. No simple explanation is presented (because none is possible) but avenues of further investigation are suggested by the discussion.

All the chapters are heavily authenticated by references to the past literature. Happily, these are presented unobtrusively by small superscript



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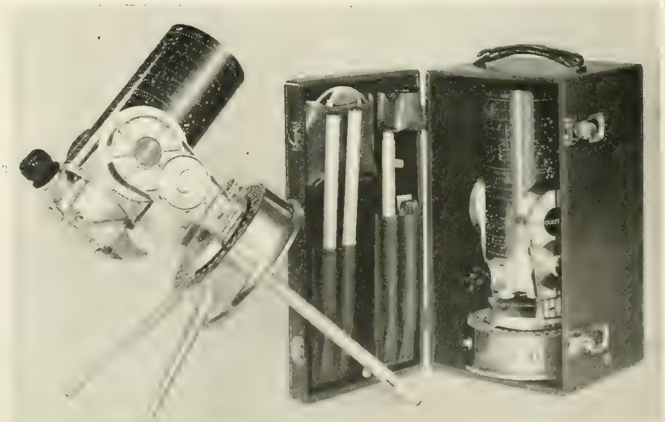

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numbers that refer to the chapter-by-chapter "Reference Notes" in the back of the book. In addition to a glossary and a selected bibliography, a number of unusual aids to the reader are given as well; these include a list of the scientific names of the snakes mentioned in the text, a table relating the evolution of snakes to geologic time, a metric conversion table, a table giving yields and toxicity of various venoms, and one on the enzymes of venoms and their sources. This mine of information has been dredged from literally hundreds of scattered sources.

Errors of fact are almost nonexistent. I noted only a few minor ones, and I would argue for a few niggling changes in the spelling of some scientific names. The use of *Constrictor constrictor* instead of *Boa constrictor*, is unfortunately, still a matter of opinion.

It seems a shame to carp about the first readable book on this vast and interesting subject, but it is regrettable that the photographic illustrations are not better (the best one was taken at the New York Zoological Park about fifty years ago) and that they were not coordinated with the text. It should be mentioned, too, that often so many facts are crammed into a short chapter that it reads more like a series of introductory statements than a thoughtful discussion.

My main complaint, though, is that there is just not enough of the Mintons in the book. They are active and interesting people who have been places and have seen things that most of us only dream about. They are thoughtful people, too, and what we need most are their reactions to these situations and their personal conclusions about them, not just a recitation of the facts themselves. Next book, maybe?

H. G. DOWLING
The American Museum

HUNTERS OF THE NORTHERN ICE, by Richard K. Nelson. *University of Chicago Press, $8.50; 429 pp., illus.*

In describing one of his first hunting trips with an Eskimo, Richard Nelson tells of a difficult journey over jumbled ocean ice to a lane of open water. Suddenly his Eskimo companion, rifle in hand, dropped to one knee and began to scratch the ice. A baffled Nelson watched as the Eskimo, making use of a profound knowledge of the behavior of Arctic wildlife, skillfully lured a curious seal close to the ice edge where it could be easily shot. As the Eskimo hauled the dead seal onto the ice, he grinned at Nelson and said, "You see, Eskimo is a scientist."

Indeed he is. Anthropologists who have worked closely with the few groups of rapidly disappearing hunting peoples left in the world are variably impressed at their detai knowledge of the environment and h to function in it. In the Arctic, it is Eskimo who are the experts. Th adaptation to their harsh environme depends upon a knowledge of natu and a set of techniques that have be developing for millennia.

Early in 1964, Nelson joined United States Air Force research pr ect on Eskimo life. His task was record how the Eskimo are able survive in the Arctic; their knowled of snow, ice, weather, and animal havior; and their techniques of hu ing, keeping warm, traveling, a surviving in any of a number of em gencies, such as falling through th ice. His method of research was engage in all Eskimo activities himse —from making the necessary gear developing proficiency in hunti techniques.

This book is a report of his r search. It is the best account that know of the hunting methods and a sociated activities of the north Ala kan Eskimo. The bulk of the book a detailed description of technique equipment, and Eskimo Arctic lor It avoids becoming tedious becaus Nelson frequently includes, as illu trations, short accounts of the exper ences of various Eskimo he knew pe sonally or was told about. Thu *Hunters of the Northern Ice* never lose its feeling for people.

When Nelson has finished describin hunting methods, he gives us a fe insightful pages on the mental atti tudes and personality characteristic that impressed him in his year o hunting and traveling with the Eskimo and that he finds particularl adaptive in the demanding Arctic environment. First, there is the Eskimo's considerable knowledge of how to react in emergencies. Much of this they learn from listening to more experienced hunters, for the Eskimo seldom doubts what he has been told by his elders. Second, the Eskimo is uncommonly self-assured in his ability to cope with any situation. This is combined with remarkable perseverance, excellent physical condition, mental and physical toughness, and a lack of aggressive behavior toward his companions when the going becomes difficult. In case these sound like common characteristics, Nelson makes it clear that in these qualities the Eskimo stands far above the average white man, who combines a disfunctional aggressiveness with a lack of stamina and toughness in strenuous situations, such as those encountered in the Arctic.

Nelson entitles his last chapter "The Death of Hunting." The older

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generation of Eskimo are nearly as skillful hunters as their parents; the men thirty to fifty years of age are still semiproficient hunters; but those under twenty-five have little more than a rudimentary knowledge of Eskimo economic culture. Modern American life has irrevocably altered the Eskimo village. A child, spending six hours a day at the village school, never gets a chance to learn the traditional skills; and if he goes to a city to attend high school, he returns to his village torn between two sets of values. He is, according to Nelson, a cultural hybrid; half-white, half-Eskimo. He can leave the village permanently, a decision made by many of the most able young people; he can find a job in the village; or he can live as an unproductive consumer. The last is possible, says Nelson, because of the various welfare programs for which the Eskimo, as American citizens, are eligible.

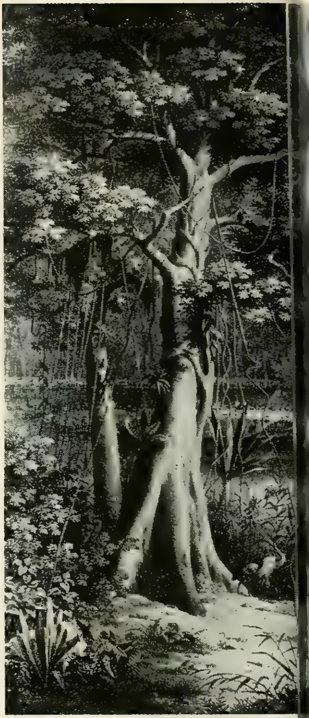
Nelson regrets the impending death of traditional Eskimo economic culture, but he is well aware that nothing can save it. At the present, and for the foreseeable future, the economy of Arctic and sub-Arctic villages will be a combination of seasonal wage work, welfare and unemployment compensation payments, and subsistence hunting. The Eskimo will survive as a people, but the self-reliant Eskimo hunter who could live solely from the meager resources of the Arctic is the product of another era and will disappear in this one.

Stanley A. Freed
The American Museum

Darwin and the Beagle, by Alan Moorehead. *Harper & Row, $15.00; 280 pp., illus.*

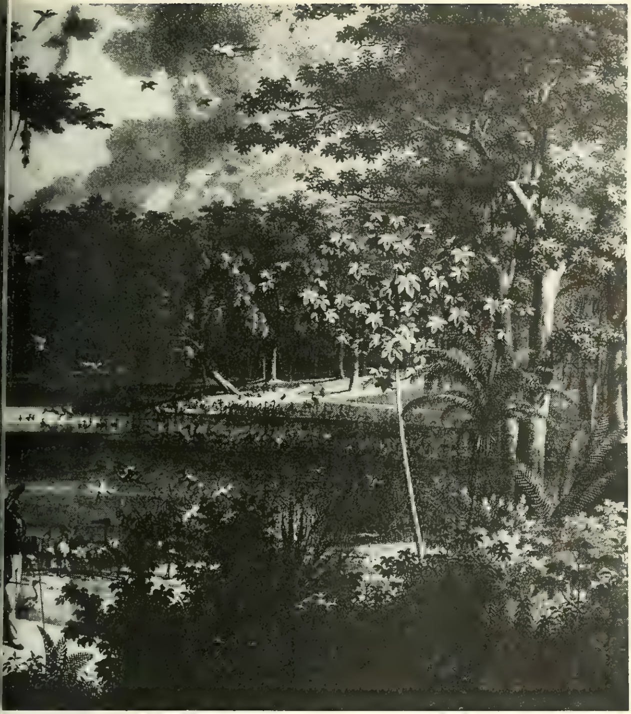
For a man who has said of himself, "I dislike writing very much and do as little as I can," Mr. Alan Moorehead has been extraordinarily productive—and on a very high level—as biographer, military historian, and author of books on travel and exploration in the Victorian age. His works, *The White Nile* and *The Blue Nile* are well remembered, as is his more recent *The Fatal Impact*, a short account of what happened when Captain Cook, for better or worse, brought the civilization of the West to the primitive societies of the Pacific. Continuing this specialty, to which Mr. Moorehead brings a great narrative gift, the author has now reworked the contemporary source materials into his own deft synthesis, presenting the story of Charles Darwin's famous round-the-world journey on H.M.S. *Beagle*, 1831-36.

The ship's mission was to extend the survey of South America begun in 1826 and to carry a chain of chrono-



metrical measurements around th
world. It was customary on such exped
tions to include the unpaid post of na
turalist. This time the choice fell, fortu
nately, upon a young man of genius
just out of Cambridge, with privat
means, and not yet settled in the world
The result was, as Moorehead notes
"the origin of *The Origin of Species.*'
Darwin varied from the standard pat
tern of the well-born young extrovert ir
being passionate about natural history
Already he was professionally competent at observing, collecting, dissecting, classifying, and making careful
notes. Mr. Moorehead, who has the literary artist's eye for character, drama,
and irony, does not overlook the fact
that the captain of the ship, a devout
fundamentalist in theology, looked upon Darwin's assignment as a splendid
opportunity to confirm the Old Testament account of the earth's creation.

Brazil. Argentina. Unmapped Patagonia, where Darwin made important
paleontological discoveries and began
to ponder the complex interdependence
of all living things, the relationship between dead and living species, and to
speculate that all life was perhaps a
continuous process. There were extensive inland detours, exciting adventures, rare specimens, new genera, an



Old drawing of Brazilian forest scene is from Darwin and the Beagle.

arthquake on the coast of Chile, and rewarding month spent in the Galaagos Islands. There Darwin formuated, in rough outline, the principle f evolution by natural selection.

Homeward-bound, the *Beagle* ran rosperously before the trade winds to ahiti, New Zealand, Australia, crossed he Indian Ocean, passed around Afria, and touched South America one ast time, reaching Falmouth on Octoer 2, 1836. A final chapter summarizes arwin's subsequent life, his domestic elicity, and his elaboration of his revlutionary ideas, which provided, as ulian Huxley wrote, "a foundation for he entire structure of modern biology."

The text is supplemented with a hronology of the voyage, a brief ibliography, and an index. A quarto n size, the volume is handsomely emellished with contemporary pictures, n both full color and monochrome. All re of great zoological, social, or anhropological interest. The reproductions and press work, done in Great Britain, are of the highest quality. The publishers blundered, however, in failing to print the ship's name, the *Beagle*, in italic type on the title page, the spine, and the dust jacket. It would be a pity if the general public, conditioned by best sellers about a man and his raccoon, or a lady and her lioness, should take up Moorehead's fine account of a great event in intellectual history, under the misapprehension that it is about Darwin and his dog.

GERALD CARSON
Author

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HOW MEN AND WOMEN CAME TO LIVE TOGETHER

INTRODUCTION TO AFRICAN LITERATURE. U. Beier, ed. Northwestern University Press, Evanston, 1967.

AFRICAN HERITAGE. J. Drachler, ed. Crowell-Collier Press, New York, 1963.

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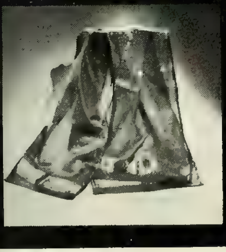

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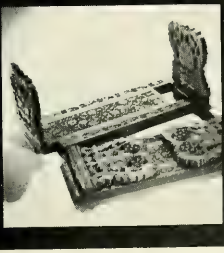

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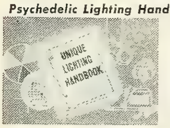

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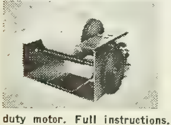

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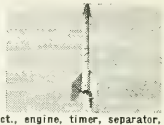

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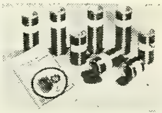

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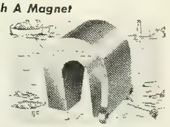

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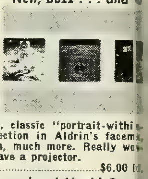

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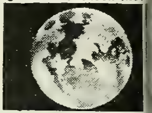

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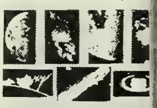

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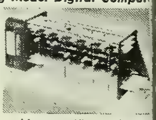

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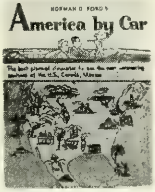

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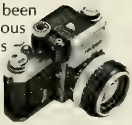

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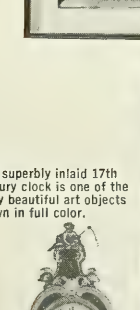

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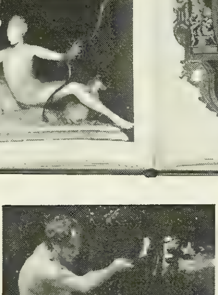

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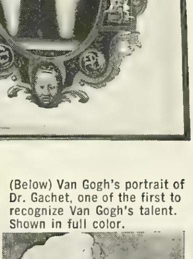

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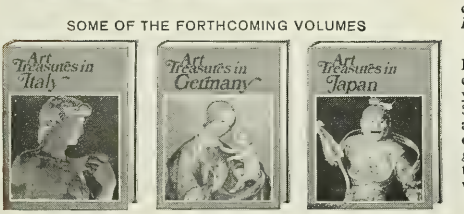

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NATURAL HISTORY

OL. LXXIX, No. 2 INCORPORATING NATURE MAGAZINE FEBRUARY 1970

THE JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

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A little Yankee ingenuity applied to potential pollution problems could solve many of Vermont's developing economic woes.

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In 1895, Prince Albert I of Monaco discovered overkill as a unique means to scientific discovery.

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Publication Office: The American Museum of Natural History, Central Park West at 79th Street, New York, N.Y. 10024. Published monthly, October through May; bimonthly June to September, Subscription: $7.00 a year. In Canada and all other countries: $7.50 a year. Single copies $1.00. Second-class postage paid at New York, N.Y., and at additional offices. *Copyright © 1970 by The American Museum of Natural History. No part of this periodical may be reproduced without the written consent of* NATURAL HISTORY. *Manuscripts and illustrations submitted to the editorial office will be handled with care, but we cannot assume responsibility for their safety. The opinions expressed by authors are their own and do not necessarily reflect the policy of The American Museum.* NATURAL HISTORY *is indexed in* Reader's Guide to Periodical Literature.

The Ohio River Commission has been fighting and winning the battle against pollution for over 20 years. Although man-made pollutants have been reduced, increasing population and industrial growth create a never-ending challenge.

Turning the tide against pollution along the capricious Ohio River.

How can you analyze water quality every hour in an ever-changing river? The Ohio River Commission considered it vital. This story is another example of how IBM, its people or products often play a part in tackling today's problems.

David Dunsmore examines some of the 130 species of fish found in the Ohio. Control of pollution has helped reduce fish mortality in recent years.

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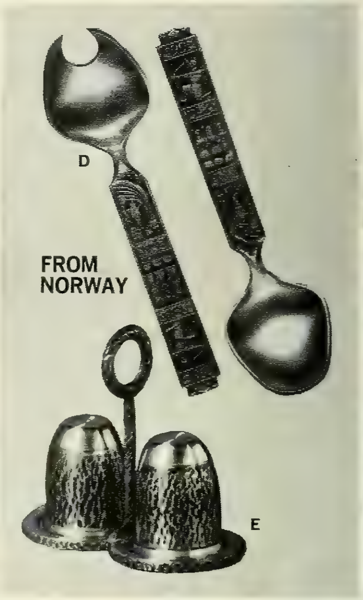

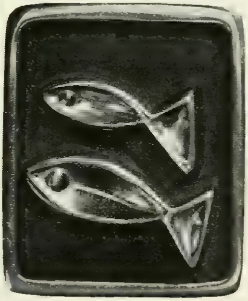

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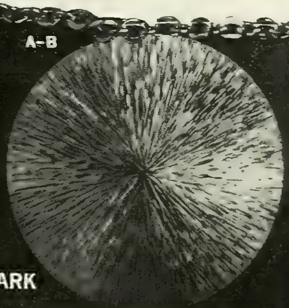

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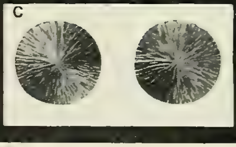

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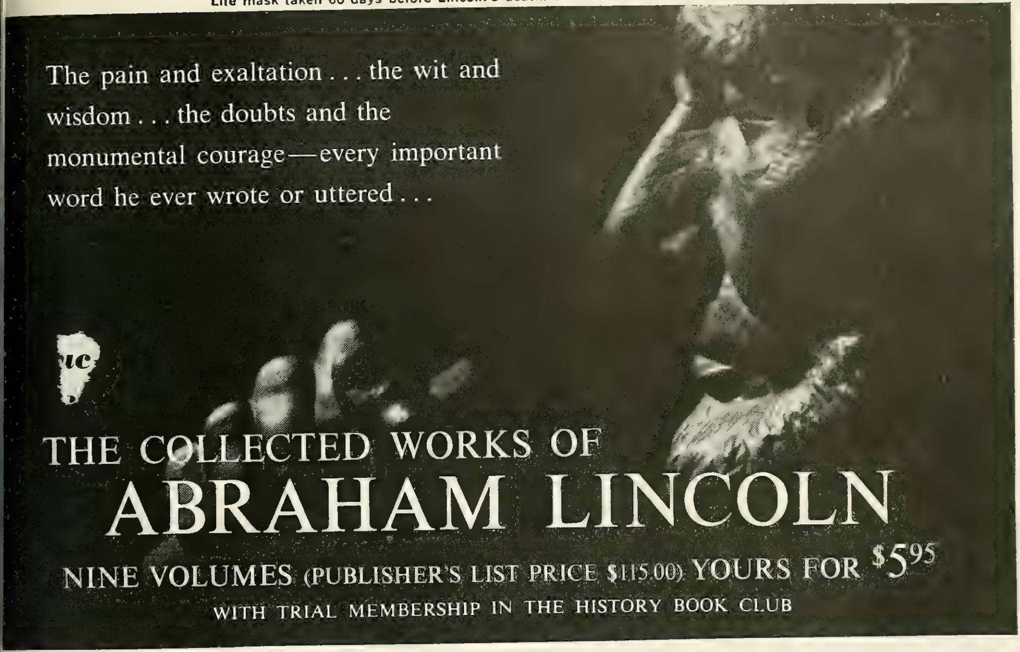

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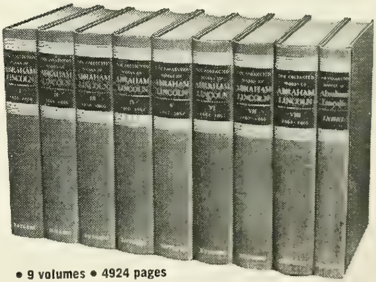

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THE AUTHORS

"Bananas in Vermont" is the first of a two-part article by **Richard M. Klein.** Dr. Klein, who has closely followed the development of atomic power in Vermont, advocates turning the potential disadvantages of nuclear plants into advantages. Professor of botany at the University of Vermont and the author of "The Florence Floods" for NATURAL HISTORY (August-September, 1969), Dr. Klein's future projects include research on the effect of light on cells, a book on plant physiology for gardeners, and a visit to Southeast Asia.

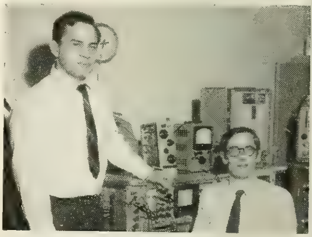
In 1966, our "Naturalist at Large" **Susan Schlee** and her four-year-old son embarked upon a scuba diving tour of Iceland, Portugal, and the Canary Islands. Their adventures, chronicled in local newspapers, earned her the unusual distinction of being the first foreign woman to scuba dive in Iceland. Upon her return, Mrs. Schlee worked (and warmed up) in Florida as a reporter of oceanographic news, and the following year was awarded a Mark Ethridge Fellowship for the study of the history of science at Duke University. A graduate of Vassar College, Mrs. Schlee is currently working on a history of oceanography at the Marine Biological Laboratory in Woods Hole.

Edward R. LaChapelle is associate professor of geophysics at the University of Washington. Since 1952, he has worked each winter as an avalanche hazard forecaster for the United States Forest Service, and is at present affiliated with the Alta Avalanche Study Center in Utah. Mr. LaChapelle's projected studies include techniques of avalanche forecasting, flow of glaciers, and climatology of the snow cover. He is the author of *Field Guide to Snow Crystals*, and coauthor with Austin Post of *Glacier Ice*, scheduled for publication soon.

Klaus-Friedrich Koch's article, "Cannibalistic Revenge in Jalé Warfare," results from two years of field work in Jalémó, an "unpacified," ethnographically unexplored region of western New Guinea. A lecturer on social anthropology for the Department of Social Relations at Harvard, fellow in oceanic ethnology at the Peabody Museum of Archaeology and Ethnology, and fellow in law and anthropology at Harvard Law School (1969-70), Dr. Koch has done field research in Samoa, Fiji, and the Ellice Islands. An ardent proponent of field work as a means to our increased understanding of intraspecies hostility and of cultural procedures for the resolution of conflict, Dr. Koch plans a long-range comparative study on law and conflict management in several South Pacific societies. At present, he is writing a book entitled *War and Peace in Jalémó: Politics of Conflict in Highland New Guinea.*

Pamela Tyler Lindstrom, the author of "The Egg Machine," is a technician in the biology department at the University of California at San Diego. A graduate of the University of Miami, she received her master's degree in developmental biology in 1966. Although Mrs. Lindstrom is currently assisting in research on cell adhesion in chicken embryos, she continues to work primarily in sea urchin laboratories.

This month's article on sleep is the result of a two-year collaborative study by **Henry Van Twyver** and **Truett Allison.** A research associate at the Veterans Administration Hospital in West Haven, Connecticut, Dr. Van Twyver, *left*, spent a year at UCLA's Department of Anatomy after receiving his Ph.D. in neurobiology from the University of Florida in 1967. Last year he joined forces with Dr. Allison to study the evolution of sleep. They plan to continue their research using radio telemetry in field studies of wild species in their natural habitats.



After completing his Ph.D. in psychology at Yale University in 1962, Truett Allison spent two years in Mexico City studying sleep in cats. He is presently research psychologist at the Veterans Administration Hospital in West Haven and assistant professor of psychology at Yale's School of Medicine. Dr. Allison has written various publications relating to sleep and to brain function in general.

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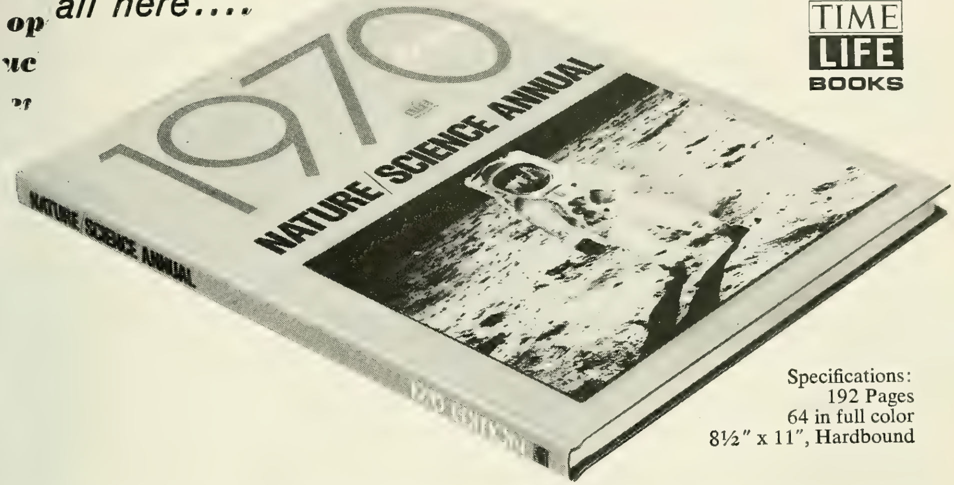

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eeping up with the astronauts kept most mericans fairly preoccupied during the ast year, at least so far as science was oncerned, but scientists themselves were eeping busy in other ways. Working at ie sites of ancient cities, or under the cean, or in laboratories around the orld, they have been involved in projcts vital and fascinating to all of us. To rovide an up-to-the-minute review of hese newsworthy developments, the ditors of TIME-LIFE BOOKS have brought ogether in a hardbound, profusely illusrated annual a record of the most imporant events in these fields last year.

The annual includes a wide variety f superb interpretive articles and picture ssays. There is an article by TIME Medi-ine Editor, Gilbert Cant, on the ethical mplications of heart transplants, (e.g., Vhen is a donor dead?) and another dealng with the discovery of Sybaris—the ncient Greek colony deemed one of the nost important archeological finds since Pompeii. Former LIFE Science Library Editor, Robert Claiborne, writes about the possibility that the world's largest and most majestic mammal, the whale, may be hunted into extinction by the end of the decade. Other articles examine the slow drift of the continents, pulsars, those stars that emit precisely regular pulses of radio energy and the comeback of steam and electric cars. The five striking picture essays include a study of the geological features of the moon; a discussion of hybrid agricultural products that may provide some answers to the world's hunger problems; and a fascinating look at some African wild dogs which display many of the same behavior patterns that distinguish early man from the other primates. All of this is contained in 192 information-filled pages, 64 of which are in full color. The book is durably hardbound and measures 8½" x 11".

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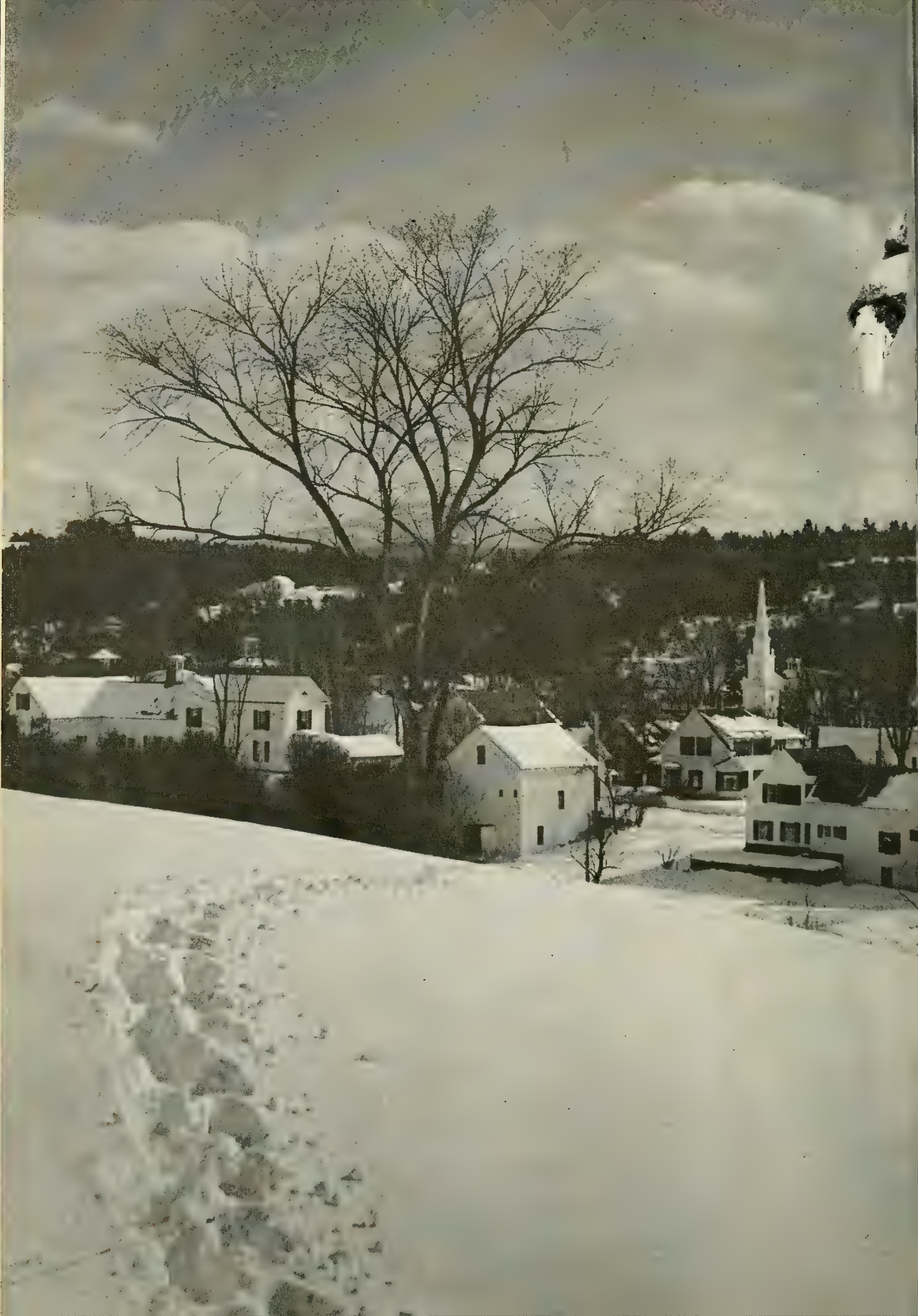


Bananas in Vermont

by Richard M. Klein

Aroused Vermonters may force new, stricter limits on the design and operation of nuclear power plants and turn one of the disadvantages of such plants into a hothouse asset

Vermont is not a wealthy state. Industry produces the largest share of state income, tourism is second, and agriculture third. It requires automation plus 40 to 70 head of cattle to make a go of the family farm, and the number of farms is decreasing each year. In the northeastern part of the state, the "northeast kingdom," where the *true* Vermonter traces his ancestry back at least five generations, some residents live close to the subsistence level; jacking of deer provides table meat. Even in the larger cities underemployment is not uncommon.

Vermont cities are not large by California or New York standards, but some, like Burlington, are seeing the development of middle-class suburbs whose residents, mostly "instant Vermonters," are putting increasing pressures on roads, sanitary facilities, public services, and, overwhelmingly, on schools. These demands on available funds can, lacking an industrial base, be relieved only by pushing up property taxes and, as was recently done, by imposing a greatly resented sales tax.

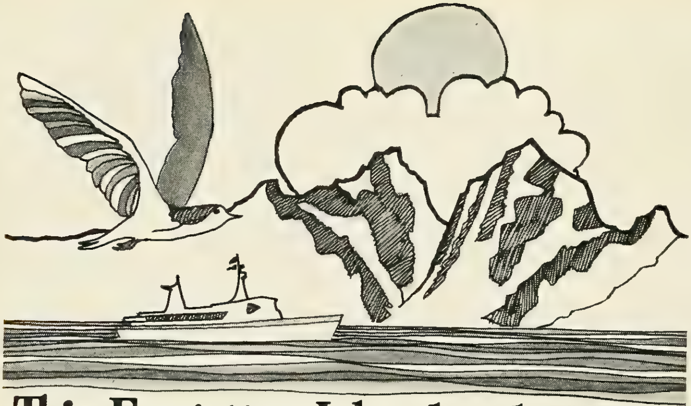
New sources of income must be found and tapped. The most obvious of these would be to bring in new industry sufficient to employ those who leave the farms and to provide a new tax base; and the second, to use the land more extensively and better exploit its natural beauty by attracting people who can build summer and, eventually, permanent homes. Many of you have seen the ads extolling "Vermont, the Beckoning Country," a publicity venture of the Vermont Development Commission. Having recently moved to Vermont, I would just as lief stop immigration altogether, although I realize that this would result in action by the federal government, an organization with more firepower than we can muster even with the muzzle-loaders now selling for exorbitant prices in our antique shops. Independent of my desire to trout fish twenty minutes from home, it is obvious that both industry and land development will be encouraged.

Despite the church mouse condition of the state treasury, Vermont is a geographic area rich in natural beauty. Its valleys are bucolic remnants of the mid-nineteenth century; the Green Mountains are soft, and, in contrast with the Rockies or the Alps, are "take-in-able." International Business Machines recognized this a few years ago when it decided to open a facility in the Burlington area, thus enabling its employees to find homes in a region unexcelled for those features that were cover paintings in the now-defunct *Saturday Evening Post.* Running parallel to the mountains for almost 130 miles and forming much of our western border is Lake Champlain, where one can still see far down into the clear depths to observe and catch bass, walleye's, perch, and northern pike. There is a deep and abiding love for this environment, and it is doubtful whether most residents would knowingly despoil the land or the water. Yet, good intentions are inadequate safeguards and it is instructive to examine more closely the problems inherent in reaching goals dictated by economic necessity.

For industry to be attracted, it must be assured of an intelligent work force, land, good and abundant water, easily reached markets, and adequate power. In our modern transport-oriented society, sources of raw materials need not be a major problem; pipelines could bring crude oil from deepwater ports to refineries on the shores of Lake Champlain or even on top of Mount Mansfield. This is an extreme, yet there are residents who would be reluctant but complacent boosters for heavy, pollutant-producing industry —"My taxes would drop and it wouldn't be in *my* backyard."

Logically, the industrial ideal would be clean, nonpolluting, skilled fabrications, but this requires power. Vermont, singularly blessed with many attributes, has few potential hydroelectric sites, there is no native coal, and present power consumption in the northeast is so great (remember the November, 1965, blackout?) that the addition of more industrial consumers of power would overwhelm present facilities. Burlington just obtained voter approval for an oil-fired turbine to serve as a backstop for its municipally owned coal-burning generator. Incidentally, the city fathers in all their wisdom will site the new plant in an existing building directly on the lakefront where there are only two beaches for the whole area, both inadequate and one now closed because of sewage pollution.

As Sen. George Aiken has pointed out, the answer to our power bind is atomic energy. Recognizing the profit inherent in serving new industry, a consortium of private power companies has already started construction of one plant on the Connecticut River near the village of



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SEYCHELLES

Vernon, and this plant, plus cont plated or completed units throu out the country, must serve a model for a Lake Champlain pla which may eventually be built at near the town of Charlotte, just so of Burlington in Addison County.

Assuming, for a moment, that other atomic energy plant is inev ble, it is obvious that it is the task aroused citizenry and concerned s entists to direct their efforts tow setting realistic limits on the desi and operation of such a plant. A cles in NATURAL HISTORY and oth publications have detailed potent health dangers and environmental sults that accompany the operati of any nuclear plant. Others ha shown that the Atomic Energy Co mission is, like many other maj federal agencies, capable of disse bling when it is useful to do so. several sympathetic opponents ha said, it is most difficult for the san agency to be directed by law both promote the use of the atom and, the same time, to regulate its us Here lies schizophrenia with a tou of defensive paranoia, and t Atomic Energy Commission is e hibiting symptoms of both the mental diseases.

Like the Pentagon, the AEC ha scarcely been questioned for close t 20 years, and in this period of tim it has consolidated an extensiv power base. Yet, in only three year there has been a series of blows t its hegemony. One hard blow was de livered by a new activist grou formed in upper New York State an centered about Cornell University Briefly, AEC and several powe groups decided to construct a fairl large plant on Lake Cayuga. Th boiling-water reactor was to be ove 800 megawatts in capacity, and lik other plants, it was to follow a desig established by AEC, with safeguard and performance standards set b AEC, and with supplementary fund provided by AEC. Prof. David D Comey and his colleagues presente —in public hearings and in two excellent publications—a serious study of the inherent and unpublicized dangers of such a plant, and finally got the AEC to withdraw its approval pending restudy. More recently, the Minnesota legislature insisted that the state can set more stringent and restrictive pollution standards than those of the AEC, a position the com-

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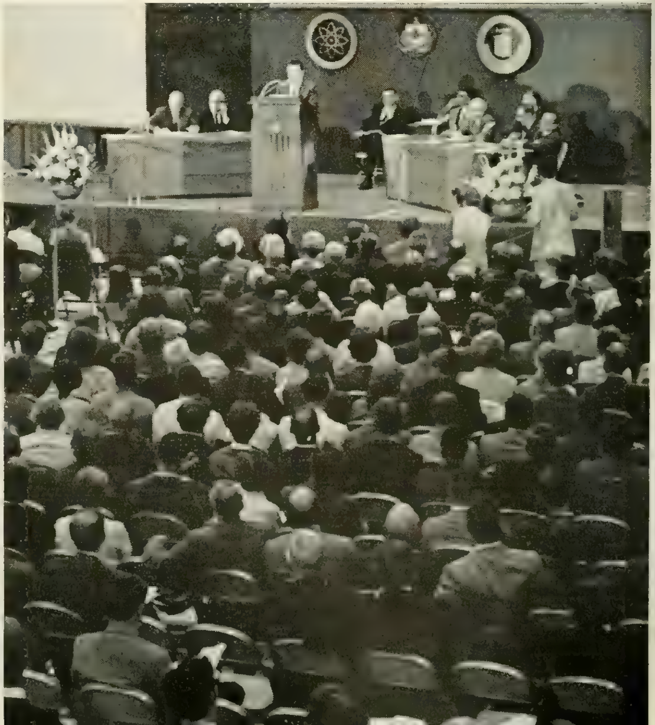
mission finds, at best, uncomfortable and, at worst, unbearable.

With, perhaps, a less firm professional base, a group of citizens from Vermont and New York have formed a Lake Champlain Committee dedicated "to eliminate water pollution from all sources . . . and to conserve the natural resources and scenic beauty of the Champlain Valley." The Vermont-New York Committee promoted and obtained passage of landmark legislation in both states to provide that smaller administrative units (like Charlotte) cannot be pressured into an environmental blunder. The temptation for a town can be strong: the tax intake in a town that has an atomic energy plant would vastly increase, while its tax rate could be substantially reduced. Citizens can picture new parks, new swimming pools, new municipal buildings, new schools and, of course, higher property values.

Senator Aiken and Governor Davis arranged for the AEC to set up a public meeting at the University of Vermont. There, many of their big guns spoke on the safety, necessity, and value of atomic energy plants in general and for Vermont in particular. The federal armamentarium included a Nobel laureate, other members of the commission, section chiefs, and a diverse sprinkling of scientific talent from the Oak Ridge National Laboratory. An expensive exhibit was brought up from Washington, miniskirted usherettes with white blazers lettered "AEC" were much in evidence, and the rostrum was graced with the AEC seal as well as those of the state and the university. Vermont, population about 400,000, was to get the "big" treatment.

Morning seminars given by their scientists were standing room only, and as a university teacher I was delighted with the educational experiences that my students got. The presentations were, to be charitable, below the standards that we set for student seminars; expected information was not forthcoming, and many in attendance got the impression that we were boondocks residents to be patronized. The formal afternoon presentations were held in the university gymnasium and attended by the academic community as well as by the general public. Remember, please, that town meetings are part of our way of life. The AEC was clearly running scared and the soothing speeches of commission members

"Vermont . . . was to get the 'big' treatment"



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and their scientists were closely followed by the audience. After the AEC had two-thirds of the program, a panel of four "environmentalists" joined the commissioners for a session of screened audience questions. It was at this point that AEC's careful plan went awry, for the questions were sharp and to the point (remember the town meeting syndrome), and the sympathy of the audience began to shift away from the official line and toward the Vermont tradition of believing what makes "good sense." This was the first time that the AEC had mounted a massive public meeting, and one of the few times that variant opinion was allowed to share the same platform. Certainly the commissioners were talking to the nation here, not just to Vermont, and certainly they were defensive and a bit apprehensive. Governor Davis received prolonged applause when he concluded the afternoon's session with a firm statement that "the right to increase safeguards should be reserved to the state." Vermont has now submitted a friend-of-the-court brief in Minnesota's suit—a development not planned by the AEC.

In October, Vermont Yankee Nuclear Power Corporation teamed up with the AEC for a two-day public meeting with the citizens of Brattl boro, near the site of the nucle power plant under construction the Connecticut River. High scho and college students as well as loc citizens attempted to get some fir information to allay their fears abo this plant but, regrettably, hea only sophistries and "facts" that a questioned by many ecologist Again, AEC struck out. At about th same time, a committee of the sta legislative council met to draft ne laws on energy and power. Vermo Yankee officials succeeded in wate ing down the strong recommend tions to the legislature. There wa they said, no quarrel with the nee to protect the environment, bu power needs had to be paramount.

Nongovernmental scientific opin ion suggests that standards of maxi mum allowable exposure to radiatio should be reduced, which would b technically possible with appropriat changes in plant design. More strin gent standards will undoubtedly in crease the construction cost of generating plant by dollar amounts that are huge at first glance. What is not pointed out, however, is that when the excess costs are amortized over plant life, the additional expense will add only a small fraction to the

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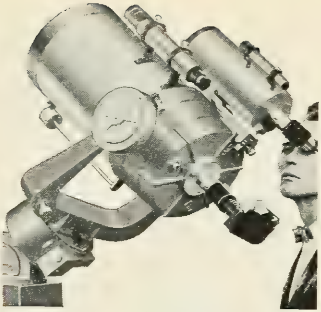

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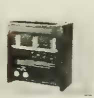

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Thermal pollution is, however, another matter. Consequences of pouring millions of gallons of heated water into any body of water are still not completely known; but to assume that because we don't know the consequences we can move right in, is ecologically dangerous and scientifically indefensible. A 500 kw. reactor cooled by lake or river water must pump 5,600 gallons of cooling water *per second*. As AEC reluctantly admits, there will be alterations in the biological and physical nature of a relatively slow-moving lake like Champlain and there will undoubtedly be changes in the surrounding countryside as well. Northern Vermont is very cold in the winter, and it is a rare year that Lake Champlain doesn't freeze over. Warmed-up, it may not freeze over completely. As cold air, borne by the prevailing westerlies, comes whistling down from the Adirondacks and crosses a stretch of open water, it will pick up sufficient moisture to produce severe fog and sleet. Addison County, self-styled "land of milk and honey" (which in fact it is) may spend six months as an inland equivalent of the Outer Banks.

Of course, if sufficiently pressed, the designers can include cooling towers or recycle their cooling water as a car radiator does. These changes would cost up to six million dollars, but in terms of total outlay they are not economically impractical. It certainly will help preserve the lake, but it will provide the makings of fog not only during the winter—if the towers can, indeed, work in the 20-below weather—but in the summer as well. And if cooling towers do not handle all the water needed for the plant, do we go back to the lake?

A bit of imagination, apparently lacking in AEC as it is conspicuously lacking in the Corps of Engineers, might just result in better solutions than the standard hot-water-into-the-lake concept, or even cooling towers. One alternative to the cooling tower is the construction of a cooling pond, which would have the advantage of permitting location of the generating plant away from the lake entirely. This would require about 1,500 acres of surface water, and if land prices were reasonable and construction costs low, the added charge would
be about $1.50 per kilowatt hour a
cost competitive with cooling towe

It seems to me, however, that
can do more with pollution proble
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winter? Thermal heat exchanger
could produce air-conditioned area
during the summer to permit mush
room cultivation. Not only could th
power companies sell a waste produc
pollutant at a profit, but they coul
sell electricity to light the green
houses. These are not just pip
dreams; Iceland has been using ther
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precisely these purposes, as well a
for heating homes in Reykjavik
Stockholm has placed an atomi
energy plant within the city limit
and uses the cooling water for hom
and office heating. Rough calcula
tions by a nonengineer (me) have in
dicated that even a modestly size
plant can produce enough waste hea
to make a portion of the Champlain
Valley into an artificial subtropical
paradise. Still a land of milk and
honey—plus tomatoes, mangoes, and
jobs. Might we not also have girls in
grass skirts undulating beneath
banana trees?

The second part of this article will appear in the next issue

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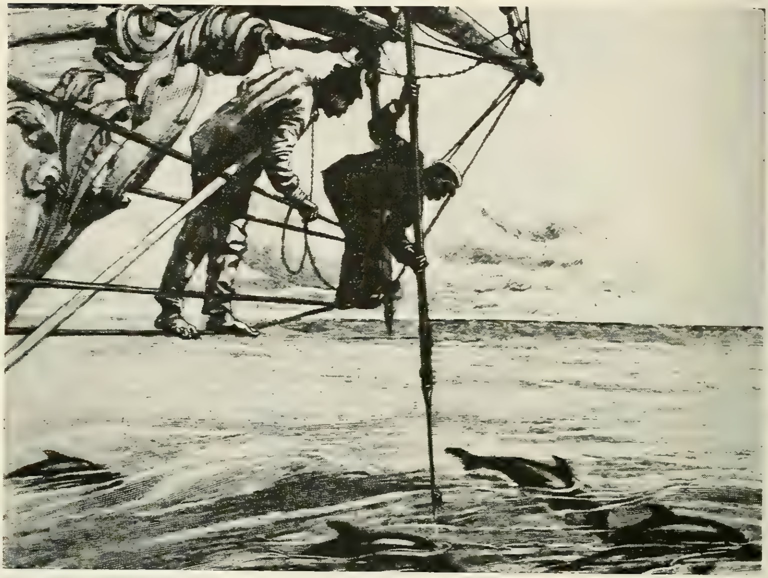
A Naturalist at Large

Prince Albert's Way of Catching Squid



by Susan Schlee

In cold, black waters thousands of feet beneath the surface of the sea swim uncounted numbers and varieties of squid. Not much has been learned about these curious mollusks, for squid see well and swim fast, and easily avoid fishermen's trawls towed slowly and blindly from a surface ship. One way to catch squid was inadvertently discovered in 1895 by Prince Albert I of Monaco as he sailed among the islands of the Azores. His method—kill a whale.

On the morning of July 18, 1895, the prince, who was on his eighth annual scientific expedition in his specially equipped schooner, the *Princesse Alice,* left the island of Terceira to trawl for deep-sea animals. The plan that day was to work in the lee of the island, for even within sight of the green hills and black volcanic peaks the naturalists on board could lower the nets and baited traps through several thousand feet of water. As the royal yacht came on station and a sounding lead was about to go over the side, the prince sighted the sails of two small boats moving seaward through the surf from the far end of the island. He guessed correctly that the boats, island whalers, were going off to hunt the sperm whales that swam in lazy herds through the waters of the Azores.

Prince Albert, as ardent a huntsman as he was an oceanographer, was particularly anxious to watch the harpooning of a whale. He ordered work stopped aboard the *Princesse Alice,* and the yacht set out after the whalers. Through binoculars the prince watched as the islanders sailed among the sporadic fountains of vapor sent up by the small herd. One of the open boats veered off toward a far group of whales, while the crew of the other stowed their sails, manned the oars, and with the harpooner poised in the bow, closed in on a sperm whale some 40 feet in length. As the prince watched, the harpooner struck and the whale thrashed violently. The men bent to the oars, pulling the boat clear of the whale's powerful flukes, which sent sheets of water twenty feet into the air with each resounding slap. The *Princesse Alice* moved in for a closer look. The open whaler again approached the whale, and the harpooner struck the animal with a heavy lance. The vapor from the whale's vent blew rose, then blood red.

"Then, right next to us," wrote Prince Albert, "began the death struggle of a giant. His enormous body, numbed and sluggish, partially submerged in the bloody sea, swayed ponderously; his large tail beat the red water violently which heaved with the swell and frothed with foam.

"The fifty persons on my boat, grouped at the bow, perched on the davits, clinging to the rigging, were dumbfounded. And me, I was moved to the marrow of my bones by the unknown grandeur of this sight. I watched as if in a dream. I was moved by this giant's agony, ex-

e Winstons aren't trying to save the world. t a little piece of it.

ere are Apaches on the reser- in Clear Fork, Arizona, who emember the last, hopeless e uprising in 1900. But for Alakay, a seven-year-old e, the enemy is not the U.S. y.

e and her people are fighting r kind of war. This time the es are poverty, disease and r. And for the first time in gen- ns, there's a chance that the es might win: thanks to the eous efforts of her own people ther Americans like the ons.

ne and Stan Winston and wo daughters live in a New suburb 2,000 miles from the ation. But it's another world. Vinstons live in a big, old house mplain about a big, new mort- Their girls have a closetful of s and "nothing to wear." They ikes, skates, games, books, rec- nd "nothing to do."

lla and her seven brothers sters have none of these prob- Her father spends as much time looking for work as he does working. Sanitary facilities are almost non-existent. Electricity has yet to reach them. Water is hauled by hand. Even the necessities are hard to come by.

rough Save The Children Fed- n, the Winstons are helping The cost is $15.00 a month. t a lot of money, but certainly instons could have thought of f other things to do with it. nately they thought of Della

her, these funds make a re- ble difference. She no longer eel embarrassed about not hav- hoes, a decent school dress, supplies, or pocket money.

me of the pressure, too, is off arents, who can now begin ng about making their home a nore livable. Also, and perhaps mportant, part of the money into a fund from which the e can borrow to start self-help cts, including better housing and a water system.

Already there is a new feeling of hope among the villagers and confidence in their ability to help themselves. Even little Della has volunteered to give some time each week to keep her school playground clean.

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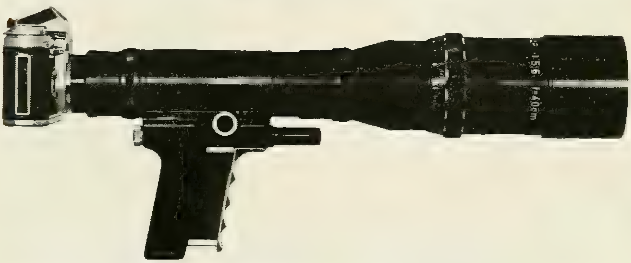

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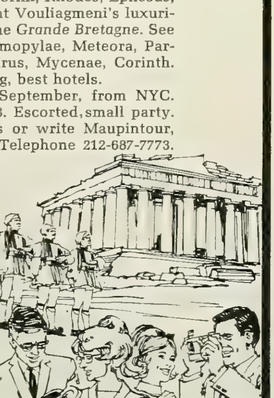

pressed so majestically, and whic . . . seemed more intense than that c lowly beings. I pitied this power c the sea who, perhaps for centurie had pushed his enormous bod across every horizon, through a depths, without fear of an enem who had played in the swells of thousand storms and who was no succumbing to the lance of a pygmy

"So much blood spilt, so huge beast dying, it seemed a great sham —like the felling of a tree or th foundering of a ship.

"Suddenly, the sperm whale cease beating the sea and, as if our ver proximity had revived him, he threw himself straight towards us at a grea speed.

"In a flash of apprehension, wondered what the shock of his body hurled violently against the side o the ship, willfully, or by an involuntary convulsion, would do when some twenty meters from us, the animal disappeared. Would a scrape o his back or a flick of his tail breal the keel of the ship or the rudder o propeller? Ten long seconds later th enormous body reappeared on th other side of the ship. It stopped an did not move again. The whalemer came round to deliver a final blow with the lance, and death crept throughout the body of the whale. The spectators trembled with a silent emotion which left them breathless.

"Now the ship and all the actors of this drama rode upon a patch of bloody water several acres large furrowed by frothy streams of deeper red which continued to flow from the animal. These dark red stains slowly mixed with surrounding waters as clouds, rolling down the sides of a mountain, slowly join with the mist of the plains.

"The enormous head lay right alongside our stern, and the lower jaw, loosely hinged, was washed open and shut by the waves. Then I saw the mouth . . . vomit several octopi or squid of a colossal size. Evidently these had been gathered during the whale's last excursion into the abyss . . . a mouthful that had hardly had time to be swallowed."

Recognizing the value of these "precious regurgitations," Prince Albert had a small boat launched to retrieve them, but even as he gave the order, the gently waving arms and tentacles were slowly sinking through the bloody water. The dismembered squid were off the stern of the ship, not thirty feet from her propeller, and the prince shouted, "Full astern!" until the turbulence created by the screw had churned the remains to the surface. The lifeboat was waiting and the squid were scooped up with hand nets and delivered to the crew and the curious scientists on deck. Enough had been saved so that five squid could be identified and, upon a later and more thorough study, it was found that all were types never described before.

"One which, alas, had lost its head in the fracas . . . [had] a body not less than two meters in length; whose form was that of a cone supplied with a large round fin partially covered with scales. Another, whose body had disappeared, could be recognized only by its crown of tentacles, that is to say by its head with its eight arms, each the size of a man's, and each studded with a hundred suckers armed with sharp and powerful claws. . . ."

Although clearly puzzled by the foreigners' concern for whale vomit, the whale fishermen were delighted when Prince Albert offered to tow their whale to shore for them. The strange procession got under way with the *Princesse Alice* towing the whale by its flukes, and the whaler trailing behind, attached to the head of its prey by a harpoon. It was late in the afternoon when the convoy put in to Negrito Bay where, on the following day, the whale was to be cut up and boiled down in the Azoreans' primitive tryworks. The prince had asked the islanders for the whale's brain and stomach, and as they made no use of these parts, they had readily agreed.

The *Princesse Alice* could not anchor safely in the bay and so sailed back to her mooring at Angra. Several scientists from the yacht, determined not to miss the rare opportunity of seeing a sperm whale dissected—even in a less than scientific manner—returned that evening to Negrito Bay. Prince Albert and the others arrived the following morning.

The whale had been beached on the rocky shore of the volcanic island; secured by several chains, it rocked slowly as the waves broke along its sides. In spite of the scientists' eagerness, the islanders insisted that nothing could be done until the

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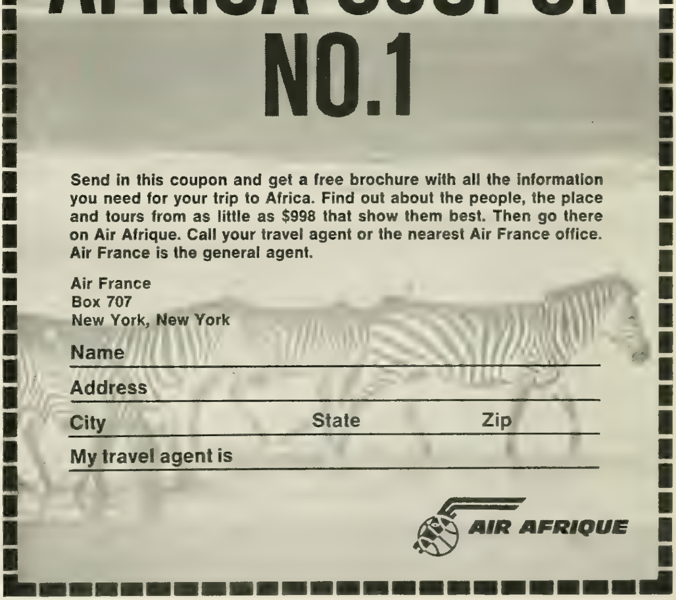

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rising tide allowed them to pull the whale higher up the beach. By midmorning the tide had reached its highest point and turned, and the fishermen followed the receding water along the sides of the whale, cutting as they went.

The sun rose higher and heat haze blurred the distant peaks and craters. Black lava stone—the building blocks of the village, as well as of the island itself—held the mounting heat, and a stench, hard to imagine and harder still to tolerate, rose from the whale. Half-naked children, bugs, and mangy dogs all swarmed over the black sand beach. Birds by the hundreds wheeled and screamed in the air, and fish darted through the surf nipping at the dismembered whale. Not until the second day of this macabre autopsy did the scientists get a chance to examine the contents of the whale's stomach—two hundred pounds of "half-digested, violet-colored stew peppered with eyeballs and squid beaks." Conditions were not eased by the acrid yellow smoke that billowed from the tryworks. It burned their throats and stung their eyes, but kept the flies away.

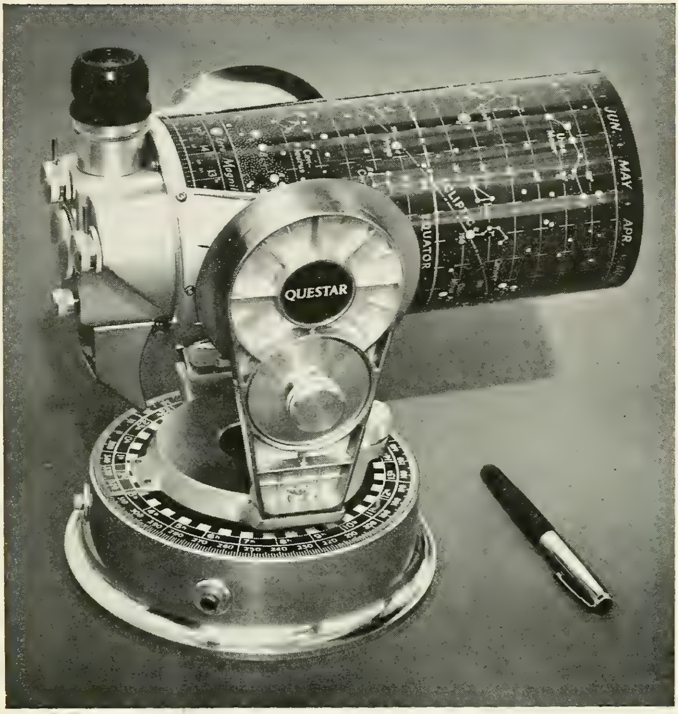
"The vengeance of the whale has begun," remarked the prince.

The remains of several more squid were fished from the whale's stomach but the scientists were not as lucky in securing the contents of its head. In draining the prized spermaceti from the head cavities, the fishermen had accidently chopped through into the brain, and the delicate tissue had rapidly spoiled.

While attending to the dissection of the whale, the scientists had ample time to examine the extensive scars on the animal's jaw.

"They clearly appear to be the marks left by the powerful suction of the [squid's] suckers," wrote Prince Albert. In his imagination there rose "a vision of colossal battles," which he thought might occur in the depths of the sea "when the terrible mammal descends to hunt its prey."

"Could they [the scars on the jaw] result from his powerful attempts to seize some giant squid? The eight arms would immediately envelop the whale's head and fix themselves there with all their suckers, while the rest of the [squid's] body, stretched to the breaking point by the whale's effort to swallow him, would finally break off at the neck



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. . . but the tentacles would remain tightly fixed to the whale until the progressive laxity of death relaxed the suckers' grip one by one. And if, by chance, the sperm whale did not wait for the arms of the squid to slough off before attacking another, one may picture a monster whose head is no longer visible beneath a mass of tangled arms from several squid."

After spending several days at Negrito Bay, the prince and his friends put out to sea again, leaving the islanders to cope with the final obligation of Azorean whalemen, the disposal of the whale's carcass. There was a strictly enforced government regulation that the remains of a whale must be towed out to sea and if, as was often the case, an onshore breeze blew the carcass back onto the beach, the whalemen were obliged to tow it off again—and again.

Prince Albert was much impressed by his unexpected acquisition of whale-caught squid and the following year he had two small whaling boats, equipped with power harpoons, brought aboard the *Princesse Alice*. A Scottish harpooner was hired to command one of the boats, while the prince directed the other. During that year's springtime expedition, confined as usual to the Mediterranean waters, the prince shot his first whale. As his whaler approached the animal, he fired the bow-mounted harpoon gun, and the sharp recoil slapped him to the bottom of the boat. A moment later he was forced to cut the line when the wounded whale sounded.

Subsequent attempts to capture whales and dolphins were more successful, and the prince made good use of his gory methods. Of the sixty-three volumes of scientific reports published in his lifetime, some of the most interesting are those containing descriptions of the squid and octopuses taken from the stomachs of whales. Yet, he did sound a note of regret. "Given their habits, the cetaceans [members of the whale family] are my most useful helpers for the study of certain oceanic domains. Unfortunately, circumstances oblige me to give them poor thanks for their collaboration, starting with a harpoon in the back and ending with the dissection and pillage of their stomachs."

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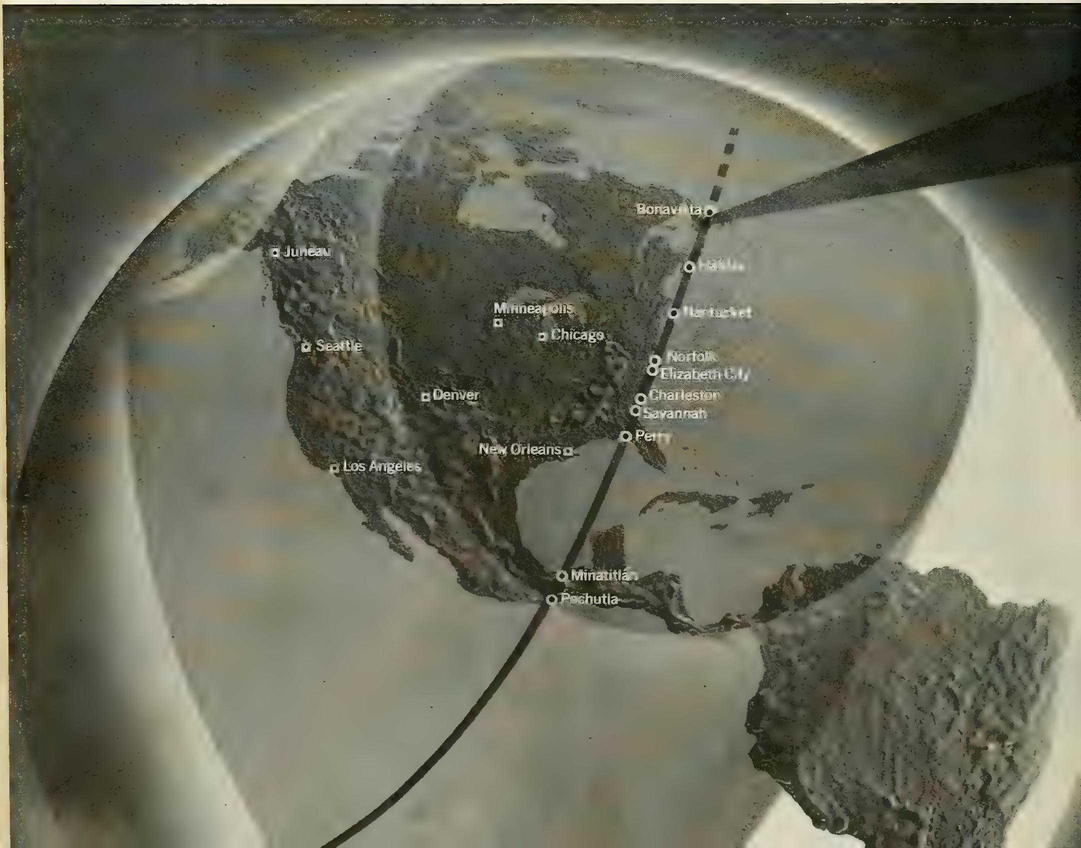
Sky Reporter

The Sun Will Darken March 7

At sunrise on March 7. the shadow of the moon will touch the earth at a point in the South Pacific Ocean. Then, for a period of slightly more than three hours. the shadow will race first eastward. then northeastward across the North American continent, leaving the earth at sunset in the North Atlantic Ocean, midway between America and Europe. A total solar eclipse will occur along the path swept by the shadow, and part of that path will cross the heavily populated eastern coast of the United States. A partial eclipse of the sun will occur over all of North America except northwestern Alaska. The total eclipse will take place in a band nearly 90 miles wide, extending over central Mexico, the northwestern Gulf of Mexico, northern Florida, Georgia, South Carolina, North Carolina, Virginia, a very small part of Maryland, Nantucket Island, Nova Scotia, and Newfoundland.

Many Americans—taking advantage of the event's proximity to their homes—will see one of the rarest, most beautiful, and most exciting of nature's sky events. Not since 1954 has there been an opportunity to see a total solar eclipse in easily accessible and widespread areas of the United States. There have been a few limited opportunities, such as the 1959 and 1963 eclipses, which were visible in the extreme northeastern part of the country, but the areas of visibility were either limited or difficult to reach. And not until the year 2017 will there be another opportunity comparable to March 7. The late twentieth century simply does not favor the accessible parts of North America with many solar eclipses.

The path of totality for the March 7 eclipse is most accessible in the areas of southeastern United States where it occurs, less so in the parts of Mexico that are

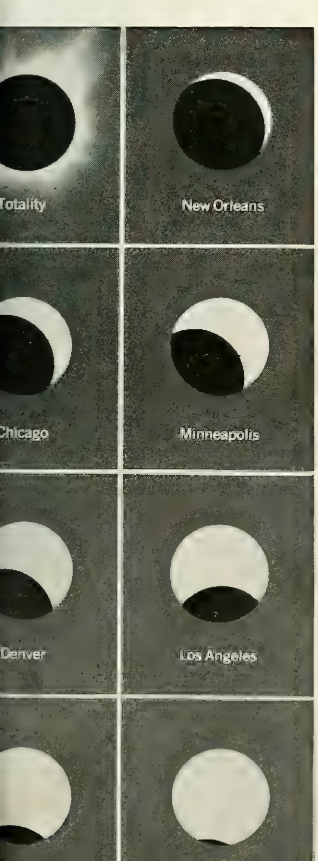


in the band of totality. The best weather conditions, however, favor the Mexican locations, specifically the southern coastal areas west of the Gulf of Tehuantepec. In this area, the mountains of the Central American isthmus serve as a barrier, forcing the prevailing easterly winds upward, where condensation removes much of the moisture that accumulated in the air in passing over the South Atlantic and Gulf of Mexico. Cloudiness is common over the north coast of the isthmus and the central mountains; but the air reaching the south coast is drier and clearer. In early March, the percentage of cloud cover prevalent in this area is in the low 20's, and chances for a March day with less than one-third of the sky in clouds are about one in three. The probability of seeing the sun at any given time on March 7 is better than 75 percent. These are considered favorable prospects for viewing the eclipse.

In contrast to these conditions, the weather outlook in the southeastern United States is marginal, if not downright unfavorable. Climatological records indicate little difference, from the point of view of weather, along the eclipse path from Florida to Virginia. Throughout this area average cloud cover in March is consistently about 60 percent; clear days occur on March 7 in about 30 percent of the years for which records are available, and the chance of seeing the sun at any given moment on March 7 appears to be about 40 percent in those areas from Florida to Virginia where the total eclipse will occur. These conditions are somewhat better than those in the northeast, where the eclipse will pass over Nova Scotia and Newfoundland, but, surprisingly, not that much better.

Most professional astronomers and serious amateurs are planning to do their work in the region of Mexico where weather conditions appear to give the greatest chance for success. There are also other factors that favor the Mexican location. The sun will be higher in the sky at the time of the eclipse, the total eclipse path wider, and the duration of totality longer than at any other location in North America. As compared to northwestern Florida, where the best conditions in the United States occur, in Mexico the sun will be 10 degrees higher during the eclipse; the eclipse path 8 miles wider (almost 10 percent); and the totality will last almost 20 seconds longer (3 minutes 31 seconds). Along the total eclipse path east and north of Florida, the sun is progressively lower, the path of total eclipse narrower, and the duration of totality diminishes continually.

Other factors characteristic of the best locations in Mexico are their isolation, difficulty of access, and



Map shows the path totality will follow across lower Mexico, the southeastern United States, and eastern Canada.

The light shading indicates the total area from which some part of the eclipse will be visible.

The dark shading and the black cone show the area from which a partial eclipse and totality, respectively, will be seen at one instant of time.

The sketches adjoining the map show how the sun will look at mid-eclipse for cities at varying distances from the path of totality; sketch at top left shows totality.

In the tables, local times are given for when the partial phase will begin; totality or mid-eclipse will follow by as much as an hour and a half.

In the table for cities not along the path of totality, the percentage of sun covered is that at mid-eclipse.

Eclipse phenomena: Cities along totality

City	Eclipse begins (local time)	Duration of totality	
Pochutla, Mexico	10:06 A.M.	3 min.	13 sec.
Minatitlán, Mexico	10:14	3	22
Perry, Fla.	11:55	3	13
Savannah, Ga.	12:02 P.M.	3	02
Charleston, S.C.	12:05	2	35
Elizabeth City, N.C.	12:16	2	44
Norfolk, Va.	12:17	2	39
Nantucket, Mass.	12:31	2	06
Halifax, N.S.	1:42	2	16
Bonavista, Nfd.	2:34	2	02

Eclipse phenomena: Other cities

City	Eclipse begins (local time)	Percentage of sun covered
Boston	12:31 P.M.	97
Chicago	11:10 A.M.	71
Dallas	10:42	71
Denver	9:51	46
Helena, Mont.	10:03	29
Juneau	9:29	04
Kansas City, Mo.	10:58	64
Los Angeles	8:28	36
Minneapolis	11:11	57
New Orleans	10:45	89
New York	12:25 P.M.	96
St. Louis	11:02 A.M.	73
San Francisco	8:37	27
Seattle	9:02	18
Mexico City	10:10	90
Toronto	12:22 P.M.	81
Victoria, B.C.	9:05 A.M.	16

sparsity of population. Only two roads, not completely paved, serve a few small mountain or coastal villages. These conditions do not pose an important obstacle to the ambitions of the professional or serious amateur astronomer, whose work usually requires him to set up his instruments and test his procedures several weeks or even months in advance. Aside from the lack of electric power and other conveniences that he may regret, he rather favors the isolation and difficulty of transport, for these guarantee freedom from large numbers of curious visitors.

Others who wish to see the eclipse may be willing to sacrifice some advantages for the convenience and accessibility found along the eclipse path in southeastern United States. In selecting an observing location in this area, there is little to choose from based on climatic conditions, although as the day approaches, weather forecasts could well suggest some preference. Aside from this problem, other factors generally favor the more southerly locations as close to the center line of the eclipse path as possible; these assure the highest sun, the widest path of totality, and the longest duration of totality. The total eclipse will last from 3 minutes 13 seconds along the Florida Gulf coast to 2 minutes 55 seconds in eastern Virginia; the path of totality will range from nearly 90 miles wide in Florida to about 83 miles in Virginia.

The eclipse path in the southeastern United States will pass over many small communities and near or over several large cities. Savannah, Charleston, and Norfolk are within the path of total eclipse; Tallahassee, and Wilmington (North Carolina) are almost exactly on the edges of the path; and Jacksonville, Augusta, and Richmond are within easy driving distance of the total eclipse path. The entire area is well served by roads, public transportation into or near the eclipse path is excellent, and facilities for travelers are abundant.

Those who cannot or do not travel into the path of total eclipse will, throughout the United States, see a partial solar eclipse. The portion of the sun that will be covered will be greatest in areas adjacent to the path of the total eclipse, and will diminish with distance to the west and north of the path. At New York City, for example, where the total eclipse will occur in the nearby Atlantic Ocean, nearly 96 percent of the sun's diameter will be covered by the moon at mid-eclipse, leaving only a small crescent of the sun visible. The magnitude of the eclipse will be 72 percent at Chicago, 46 percent at Denver, 36 percent at Los Angeles, 18 percent at Seattle, and only 4 percent at Juneau, Alaska. The eclipse will occur during the morning hours along the west coast, progressively later in the day to the east, and in the early afternoon along the east coast.

Thomas D. Nicholson

An Eclipse-Watchers Guide

A total eclipse of the sun is so spectacular and so relatively rare that even veteran watchers experience "eclipse fever" and forget to take the lens covers off their cameras—even forget to take pictures. In the excitement, secondary phenomena are often overlooked entirely. To help readers prepare for the March 7 eclipse, here are some of the things they may expect to see. Probably not all of those mentioned will occur; no two eclipses are the same. But many will; observers who know what to look for have a better chance of seeing it.

Partial phase: Along the path of totality, the partial phase will last well over an hour both before and after totality. First contact of the moon with the sun is essentially undetectable, but within a few minutes observers will see the moon cutting a scallop out of the lower right-hand edge of the sun. For the next hour or so the moon will move across the face of the sun, covering sunspots as it goes; the mountains and valleys on the edge of the moon will be silhouetted against the bright solar disk.

If the foliage around the observer is suitable, tiny overlapping crescents of light may dapple the ground beneath trees, the result of innumerable "pinhole camera" effects as the sunlight filters through the leaves.

By the time the sun is 80 percent eclipsed, it will have the shape of an elongated crescent. Sunlight will be coming only from the sun's redder limb regions; over-all illumination on the ground will be dusky and yellow, becoming progressively redder until totality.

As totality approaches, events will accelerate: the sky will darken, the temperature drop, and dew may fall. Cumulus clouds will tend to dissipate, but ground fog may form in lowlands. Shadows will become sharper as the sun narrows to a thin arc, and all objects will appear to be closer to the ground.

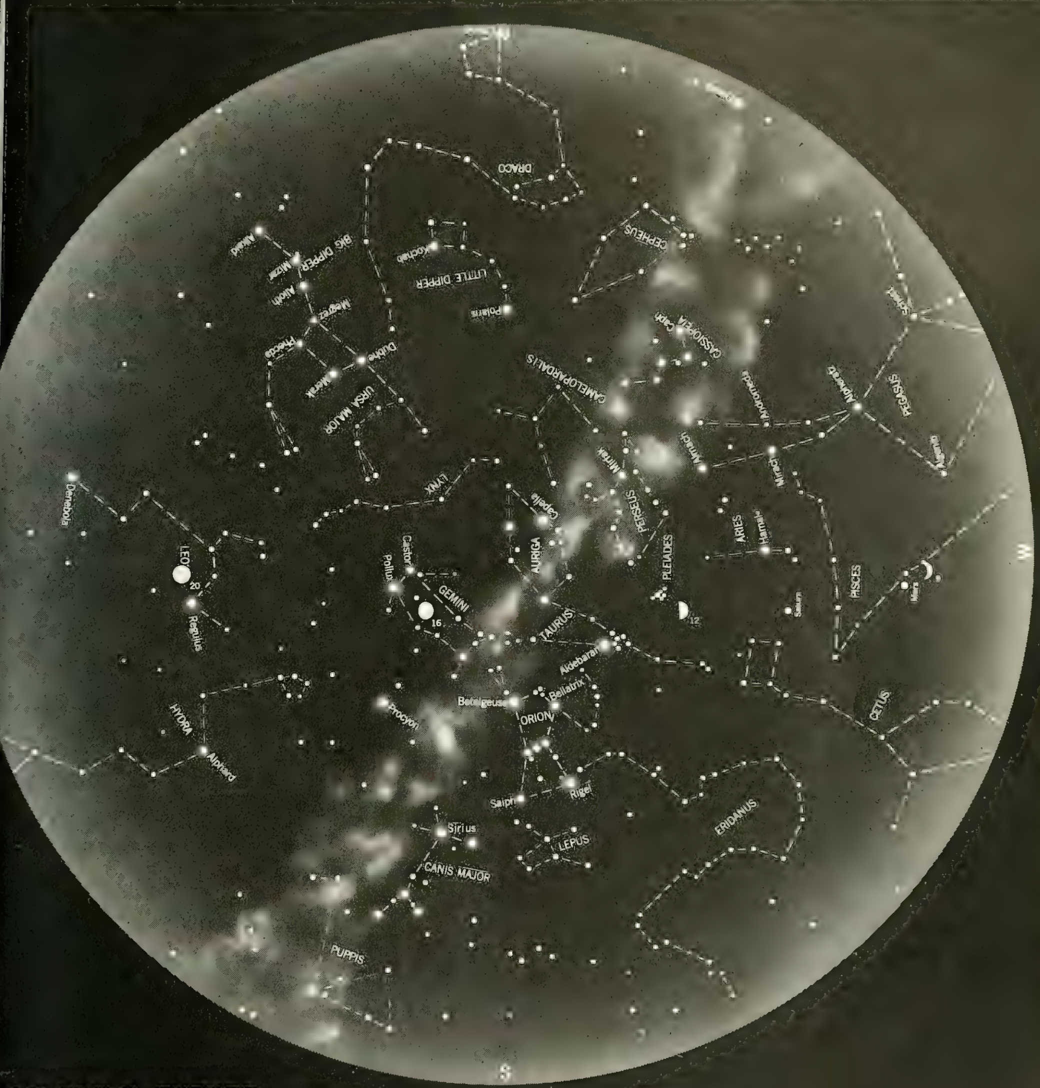
For a few minutes before and after totality, an observer may see faint rippling waves of dark and light moving across the ground or along the sides of buildings at six to ten miles per hour. Called "shadow bands," these waves apparently result from irregularities in the earth's atmosphere. The darker bands are two to eight inches across and are separated by eight inches to two feet. They can best be seen if a white sheet is spread on the ground.

On March 7 an observer should look to the southwest to see the approaching lunar shadow, appearing like a great storm on the horizon. As it approaches it will appear to widen, filling more and more of the southwestern sky. It can be seen best if it passes over clouds to the north or south of the observer. Clouds will take on a yellowish-tan color, merging to reddish umber at the shadow edge. The edge itself will be diffuse and of a deep umber color, changing to slate, violet, or gray deeper in the shadow. Moving at some 1,500 miles per hour, the shadow will bear down on the observer like some mighty wall of darkness, and at the onset of totality will engulf him like a curtain of fog. In the last few seconds of the partial phase, the shadow may even be seen moving across the ground, especially if the observer is high enough above the surrounding terrain.

As the thin solar crescent narrows, it will begin to contract from the "horns" at its tips and break up into small segments known as Baily's beads. Rounded or oblong in appearance, they sometimes seem to merge or flow together. Caused by the irregular mountains and valleys on the lunar limb, they last only a few seconds.

At this point the sunlight will be so feeble that the

Continued on page 78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CELESTIAL EVENTS

New moon is on the 6th, after which the moon comes into the evening sky. First-quarter is on the 12th, and full moon is on the 21st. The moon then returns to the morning sky until month's end, with last-quarter on the 28th.

Venus, Mars, and Saturn are evening stars, but Venus is too close to the sun to be seen easily. Mars and Saturn are in the southwest at dusk and set in the early evening. Mercury may be seen as a morning star, low in the southeast, during the first week. Jupiter rises before midnight and remains in the sky until dawn.

February 5: Mercury is at greatest elongation (west) in the morning sky. This is not a favorable elongation; the planet is still quite low at sunrise.

February 5: The moon is at perigee 8 hours before the new moon, and the perigee spring tides on the 6th will be higher than normal.

February 20-21: The full moon moves past the star Regulus, brightest star in Leo, tonight. The moon rises to the right of Regulus on the evening of the 20th, passes the star about 9:00 P.M., EST, and then moves increasingly farther to the left (east) during the morning. The moon occults the star over parts of Canada, Europe, and Asia.

February 21: There will be a partial eclipse of the moon shortly after 3:00 A.M., EST, but earlier by an hour in each time zone to the west. Only about 5 percent of the moon will pass through the earth's shadow, however.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 9:15 P.M. on February 1; 8:20 P.M. on the 15th; and 7:30 P.M. on the 28th; but it may be used for about an hour before and after those times.

FROM SNOWFLAK

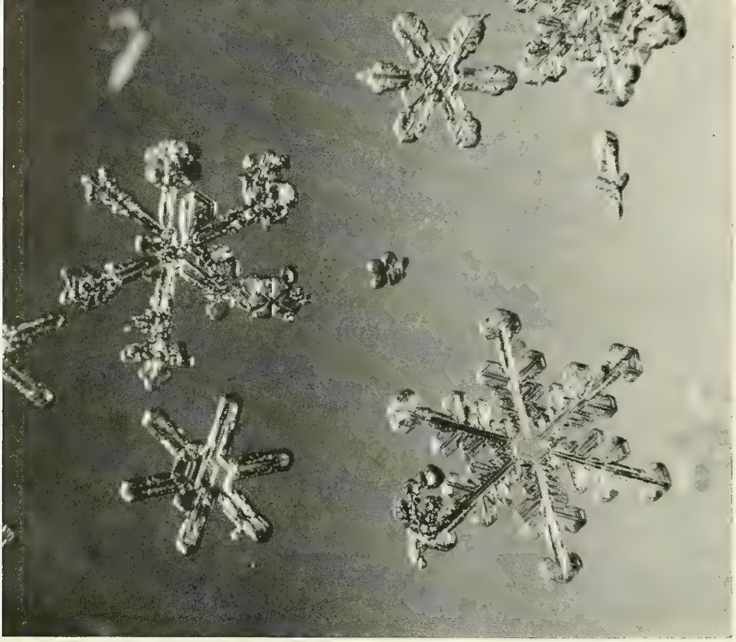
Although the snow crystal is a thing of beauty,
structural changes can lead to spectacular, sometimes disastrous
surges of accumulated snow down a mountain

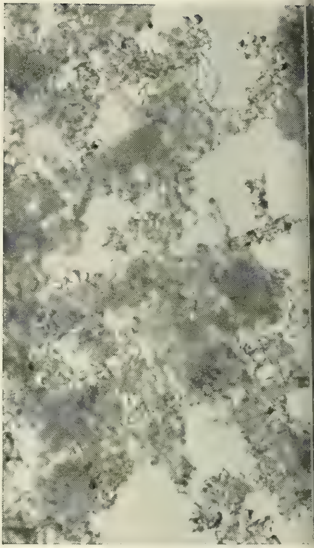
by Edward R. LaChapelle

TO AVALANCHE

Snow is one of the most variable substances found in nature. Some snow surfaces glitter in the sun, while others remain dull and gray. Some snow floats as fluff on a modest breeze, while other kinds, packed like concrete, can resist a mountain gale. The skier may find his favorite slope varying in texture from that of bottomless feathers to an icy skating surface. Some snow will remain firmly planted where it fell, other kinds will slip off a steep mountainside at the slightest touch.

The varied forms that snow can take are familiar to everyone who lives in a climate with cold winters. The householder who shovels half his walk clear of fresh snow and leaves the other half until the next day is uncomfortably conscious that





The intricately branch
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the stiff and heavy snow he comes back to is not the same kind that floated down from the sky. The skier who carefully times his tour on a sunny April morning enjoys the delights of corn snow, but the eager beaver who comes too early skis on icy "boiler plate," and the lazy one who waits until late in the day finds himself up to his knees in slush—skis and all.

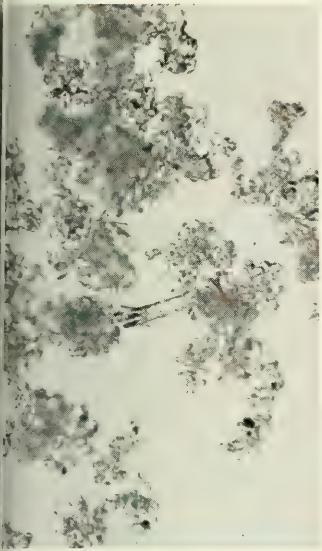
Other snow forms are less familiar. A recrystallized type, sometimes called sugar snow, can occur as hidden layers deep within a snow cover. Because it has little internal cohesion, when disturbed it flows freely like dry sugar, and an unsuspecting skier or snowmobile driver can suddenly sink clear through to the ground. Another type, the pellet snow peculiar to certain mountain storms, falls as rounded grains resembling hail. When they drop in large quantities at certain temperatures, these pellets—some as large as peas—flow off steep slopes in a constant stream. The whole mountainside comes alive with such rivulets, which deposit the pellets in deep piles in the hollows and ravines.

Most striking of all the effects generated by snow variations is the snow avalanche. Caused by hidden changes deep within the snow, or by the deposition of one last overload of new snow on a weak layer formed perhaps a month before, avalanches are among the most spectacular forces of nature. They range in size from the harmless trickle of a few handfuls of snow to the fall of millions of tons in a single surge that can sweep whole forests down a mountainside. In one way or another all start with certain combinations of snow crystals and patterns of winter weather. Distinguishing these combinations from the ones that produce stable, harmless snow takes skill, experience, and sometimes a certain seat-of-the-pants intuition.

Let us begin by looking at the "raw material." A snowflake is a group of cohering snow crystals. While it is true that "no two snowflakes are ever alike," this is only part of the story. This traditional phrase generates a vision of ordinary, hexagonal snow crystals repeated in endless variations. Nature, in fact, offers a far wider variety of snow crystals; the common, hexagonal star is but one of several basic patterns. A recent classification scheme devised by Japanese scientists distinguishes 79 different kinds of snow crystals, but still includes one "miscellaneous" category to accommodate the leftovers. Even the greatly abbreviated International Snow Classification recognizes ten different forms of solid precipitation. This diversity applies to falling snow as it arrives from the sky.

It is also true that even the same deposited snow crystal is not alike from one moment to the next, for snow shapes of all kinds are ephemeral. This susceptibility to change is characteristic of substances composed of solid particles—in this case, ice—that are close to their melting point. Only below -40°F. can snow crystals persist for days in their original form. At milder temperatures, metamorphism begins to alter their shape as soon as they reach the ground. Change is the one contant feature of snow.

The intricate shapes of newly fallen snow are unstable because they represent a high ratio of sur-

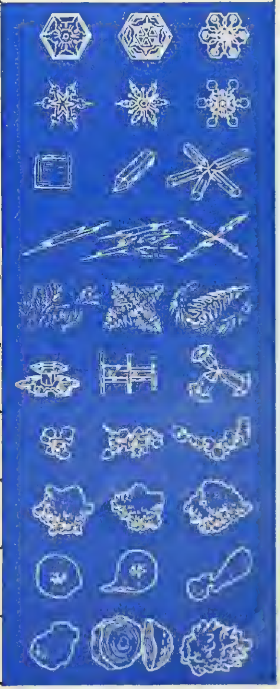


face area to volume and consequently, a high surface free energy. Natural processes always work in this way to minimize this surface energy. In the case of snow crystals this process reduces them from varied and often beautiful patterns to rounded grains of ice. The reduction takes place largely through the diffusion of water vapor from one part of the snow crystal to another, leading to the formation of old snow. This converted snow is "old" in the crystallographic sense, rather than in a chronological one, for the rate of conversion varies widely with temperature. Near the freezing point, snow becomes old in just a few hours. This is the process of destructive metamorphism, which operates in the absence of large temperature differences within the snow.

If gradients greater than about 0.2°F. per centimeter of snow depth are present, a different process takes place: water vapor leaves one crystal and is redeposited as ice on its colder neighbor. Thus new crystals are formed with shapes entirely different from what they were in the atmosphere. Hoar is the general name given to ice deposited from water vapor, hence these crystals formed deep within the snow cover are called depth hoar, the sugar snow referred to previously. If severe temperature gradients are maintained for many days, the whole snow cover may pass through the vapor stage and be recrystallized to depth hoar. The mechanical strength of snow is drastically reduced by this process, which occurs most frequently in shallow snow layers during very cold weather.

But depth hoar formation is not the only factor that helps explain avalanche release. The diverse types of snow crystals formed in the atmo-

Types of Solid Precipitation

ERM	REMARKS	GRAPHIC SYMBOL	EXAMPLES
lates	also combinations of plates with or without very short connecting columns	⬡	
tellar rystals	also parallel stars with very short connecting columns	✳	
olumns	and combinations of columns	▭	
eedles	and combinations of needles	↔	
Spatial dendrites	spatial combinations of feathery crystals	⊛	
Capped columns	columns with plates on either (or one) side	⊢⊣	
Irregular particles	irregular compounds of microscopic crystals	⌒	
Graupel (soft hail)	isometric shape. Central crystal cannot be recognized	✳△	
Ice pellets (sleet)	ice shell, inside mostly wet	△	
Hail		▲	

From International Snow Classification.

sphere can also be modified by accretion of rime during their fall.

The deposition of rime on exposed objects during winter storms is familiar to many people. but few recognize the important role it also plays within clouds—for it is in the clouds that the foundation for a subsequent avalanche is often laid. Cloud particles consist of either tiny water droplets (water cloud) or tiny ice particles (ice cloud). If a water cloud is cooled below freezing, the liquid droplets often will not freeze until the temperature reaches very low values. Such supercooling occurs most readily in pure water within an uncontaminated environment. The distilled water making up cloud droplets fits this requirement very nicely. These droplets can remain liquid only as long as they do not strike any solid object, especially ice, which can serve to nucleate freezing. When wind drives a supercooled water cloud against mountain peaks or other exposed objects, the accumulation of freezing droplets leads to formation of the familiar rime feathers built up toward the wind.

Snow crystals generated by the atmosphere's higher and cooler clouds (usually ice clouds) may fall through the supercooled water clouds at lower levels. Whenever they strike a cold water droplet, the droplet freezes, adding its rime to the crystal. If the cloud is thick and supercooled droplets numerous, the extra icing can completely obscure the original crystal, eventually forming a rounded ball known as graupel, soft hail, or pellet snow. Because most precipitation originates as snow (melting to form rain), and because supercooled water clouds are very common, a substantial part of the total precipitation reaching the earth's surface is extracted from clouds in the form of rime.

In many climate zones, particularly those exposed to maritime conditions or those with abrupt mountain ranges that rapidly lift approaching air masses, 90 percent or more of the snow crystals that reach the earth's surface are rime-coated to some degree. These rimed crystals lose their ability to sparkle in sunlight, and the snow takes on a dull, white appearance.

The mechanical properties of such snow are also modified. Rime-coated crystals are better able to bond to one another than rime-free ones. so the snow forms a more cohesive layer, much in the way that sugar cakes in a bowl during damp weather. Because the stiffness of a snow layer is sensitive to the size of its component grains, doubling the grain size makes the layer sixteen times stiffer. As a result, layers composed of heavily rimed graupel particles, which are usually much larger than plain snow crystals, are extremely reluctant to deform, in contrast with the much more plastic snow made up of smaller, rime-free crystals. Stiff snow layers cause the most persistent avalanche danger.

Rime has still another effect on already fallen snow. It acts as a cement among snow crystals deposited on windward slopes exposed to supercooled clouds. As the crystals reach the ground, they come in contact with rime being formed on the snow surface, and cementing occurs instantly, in contrast to the slower bonding, or sintering, already described. The

product is a very tough, cohesive deposit of mixed snow and rime that resists the erosive power of the wind. This snow stays where it lands on the mountain. In the absence of rime-cementing, more common in continental climates, the snow is readily blown away and deposited in sheltered lee areas. Such rearrangement of snow by wind has a marked effect on where avalanches will occur.

The presence or absence of rime-cemented snow also determines in striking fashion the winter appearance of high mountains. With relatively little or infrequent riming during snowstorms, the windward mountain slopes are swept clean of snow by the wind, leaving large areas of bare rock exposed throughout the winter. But if an abundant supply of rime is present, the mixture of rime and snow builds up steadily during the winter into a thick mantle that resists even hurricane-force winds.

There are two principal types of avalanches with distinctly different modes of origin. These are the loose-snow avalanche and the slab avalanche. There is seldom any overlap between the two—the kinds of snow causing one type rarely cause the other. Snow rangers, ski patrolmen, or highway maintenance crews—who commonly deal with avalanche hazards—always look for this distinction because it determines the character of the danger and the means for dealing with it.

Loose-snow avalanches form when snow crystals with little attachment to one another accumulate on a slope that is steeper than the natural angle of repose. This type of situation may come about through snowfalls with little wind or through metamorphism of previously cohering snow crystals. The intrusion of liquid water produced by rain or snowmelt can have the same effect. In either case, such snow behaves very much like dry sand placed on a board and carefully tilted up to an angle where it remains precariously perched—until a slight disturbance sends it cascading down to form a pile with gentler slopes.

left, a small loose-snow
alanche plunges down steep
hwarzmönch, in the Alps;
low, in Utah, depth hoar
stered the breakaway of a
ge slab avalanche that tore
ay the entire snow cover.

When snow on a mountainside is in a condition of precarious equilibrium, any slight disturbance can set a few crystals in motion; as they fall, they dislodge more and more crystals until a loose-snow avalanche is in motion. Such avalanches fall in uncounted numbers each winter. Most are small and usually harmless. Snow crystals, especially the stellar patterns with little or no rime on them, are the ones that most readily form these avalanches. Because the snow is highly unstable it avalanches readily when only a few inches have accumulated, thus limiting the likelihood of large avalanches.

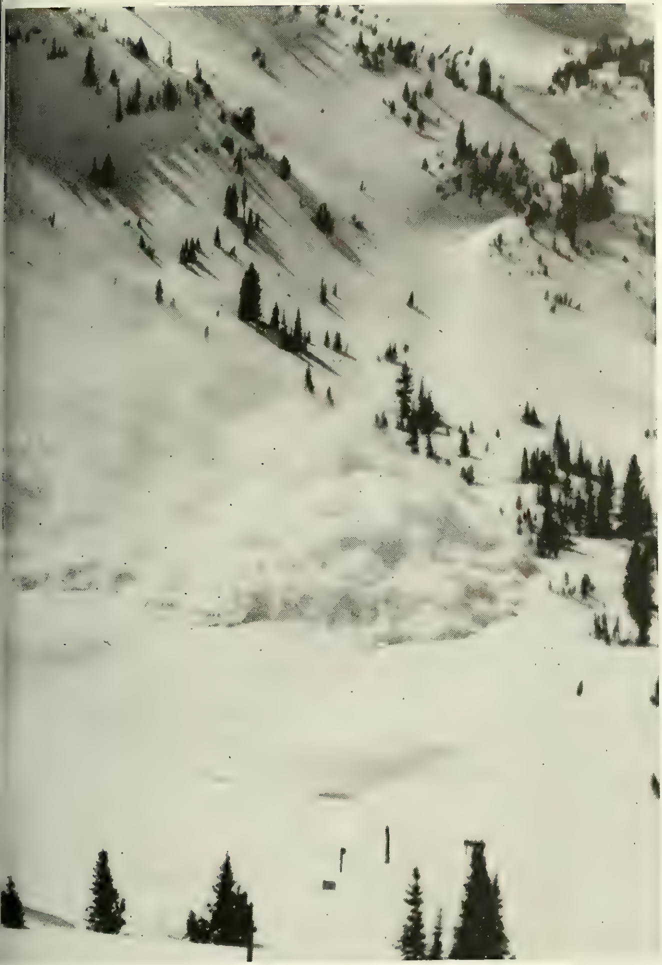
Of course, if the snowfall includes the more intricately branched stellar crystals, these tend to interlock when they first fall, building a relatively stable snow layer with a texture like matted felt. But metamorphism soon breaks up the intricate crystal arms, destroying the feltlike structure. Such snow tends to produce loose-snow avalanches a day or two after it falls. But these avalanches, too, are seldom large and destructive. The dangerous ones are more apt to be found in the wet snow of spring, at places where deep layers of snow accumulated on a slope are rendered unstable by the lubricating effect of liquid water percolating among the grains. Almost all really large, dangerous avalanches, however, originate as snow slabs. Because a wide variety of snow conditions can create the slabs, these avalanches are difficult to predict. In general, whenever snow lies on a slope in a cohesive layer, which, for some reason, is poorly bonded to other snow layers or to the ground, the potential exists for slab avalanche release. Such a layer can slide away as a coherent blanket. Moreover, instead of originating at a point and growing as it descends, like the loose-snow avalanche, the slab avalanche starts out big. A whole mountainside can slide at once, and if this mountainside happens to be a mile wide, then a mile-wide avalanche suddenly springs into motion. Most avalanche accidents involving skiers start as slabs, and most are set loose by their victims, who ski into a danger area and are suddenly caught in the snow fracturing all around them. Very much in the minority are those avalanches in which unsuspecting victims are engulfed from above.

Examination of the slab phenomenon reveals that every snowstorm deposits a distinct layer of snow, each with its own internal crystal types and water content. Various weathering influences between storms (wind drift, sunshine, evaporation, frost) alter the surface of each new layer before the next storm arrives. Some of these modifications leave a surface to which the next snow layer adheres poorly. The delicate crystals of hoarfrost are one example of a poor bonding surface; another is the slick surface of ice left by a freezing rain. Or a thin snowfall of fragile crystals sandwiched between two heavier layers may inhibit their attachment. Most insidious are those snow layers that initially formed a good bond and still seem to be stable. However, metamorphism of the snow crystals can later weaken this bond or even the internal strength of a whole layer. The depth hoar formed by steep temperature gradients exemplifies such hidden deterioration, which occurs most frequently between the ground and the rest of the snow. When a slab avalanche breaks loose because of depth hoar, the whole snow cover slides away. Percolation of liquid water into the layer boundaries is still another cause of dangerous slab conditions.

All such circumstances lead to the same result—a blanket of snow sliding off because it is poorly bonded to the earth or snow underneath. The blanket analogy becomes clear to anyone who has tried to keep the covers on his bed on a cold night when one of them is a quilt whose slippery satin finish "forms a poor bond" with the other blankets.

If adhesion among snow layers were the only factor affecting their formation, it would be far easier to predict slab avalanches. But another property of snow complicates the situation, and is the key to their release. Snow belongs to a class of substances known as viscoelastic. Able to deform in a plastic fashion under even very small forces, it can at the same time sustain elastic deformation very much like a rubber band. The relative importance of these two deformations depends in a complicated way on temperature and snow structure. The commonest force at work on the snow cover is gravity; on the mountainside it continually causes the snow to deform in a downhill direction as well as to settle in place.

All winter long the snow, even on level ground, settles under its own weight; on slopes it also creeps along by internal deformation and glides slowly over the ground. Moreover, most mountain slopes are irregular, as is the snow cover that rests on them. This means that the creep



Giant avalanche in motion ten seconds after a 75mm. artillery shell was fired at this danger area in Wasatch National Forest, Utah.

and glide speeds differ from one part of the snow cover to another, generating both tensile and compressive stresses in the snow.

The tensile stresses are the ones that cause the most trouble. If a poorly supported snow slab is in tension under circumstances that favor elastic deformation, it is stretched out over a slope much like the thin rubber of a balloon is pulled into tension when inflated. Any small disturbance or breaking force on the snow slab—a lump of snow falling from a tree or the passage of a skier—has approximately the same effect as sticking a pin in the balloon. The slab fractures, sometimes with the violence of an explosion if the snow is hard and the stresses large. If the snow is very unstable, these fractures can propagate for miles, releasing avalanches wherever they cross a steep, open slope.

It is this ability to fracture with sudden violence that makes the slab avalanche so dangerous and unpredictable. A small disturbance at one point can set loose enormous forces, sometimes far from the original disturbance. The susceptibility of snow to this kind of avalanche release varies rapidly with time, so that a hazardous situation may arise in a few hours during a storm, then diminish rapidly afterward if the temperature is not too far from freezing—a condition that allows the snow to deform readily and relax the tensile stresses. At very low temperatures, on the other hand, the tension can persist for days after a slab situation is generated, so the snow remains in a continuously unstable and dangerous state.

The kinds of snow that can react as unstable slabs range all the way from the skier's soft "powder snow" through rock-hard wind deposits to the water-soaked spring snow that verges on slush. The key factors are weak bonds between layers and the presence of tensile stresses. Certain kinds of snow favor slab formation much more than others, especially those kinds with higher densities (more weight and consequent higher gravitational stresses) and with a good ability to sustain elastic deformation. When stellar crystals are free of rime they tend to settle or slide off in small loose-snow avalanches very readily, hence snow layers composed of these crystals are highly unstable, but a serious slab hazard seldom develops because such snow can sustain only very limited stresses—it does not build up to dangerous thickness as a slab. As an increasing amount of rime appears on the crystals, the snow layer assumes a pseudostability. The crystals bond together more readily and the thickness of a layer may increase up to several feet before a large slab can be released. Hence the rimed-crystal forms are much more effective for generating dangerous avalanches.

Other snow types, such as needle crystals and granular fragments that can pack closely together to form a heavy slab layer, are also generators of avalanches. And wind drifts on lee slopes are especially susceptible to avalanching because they are formed in deep layers of crystals that have been broken and then packed by the wind.

How do modern avalanche control measures work? Almost all aim in one way or another to prevent or relieve dangerous tensile stresses in snow slabs. In the Alps massive fences or barriers are often scattered across a mountain slope. These structures break the snow cover into smaller sections and actually support the sections by inhibiting creep and glide. Another method, requiring much lighter construction, uses a dense pattern of baffles to break up wind flow and, therefore, the deposition of continuous slab layers.

There are also more active methods of avalanche control. Where avalanches can be allowed to fall harmlessly at certain times—for example, on highways or ski slopes free of traffic—control is customarily effected by artificial release. This technique, highly developed by United States Forest Service snow rangers in national forest ski areas, usually involves detonating an explosive charge—either an artillery shell or a hand-thrown explosive—in the known fracture zones of avalanche paths. The blast shatters any slab layers present, relieving stresses and allowing the fractured slab to fall. In many cases, if the layer bonds are good, it does not fall; but the relief of stress eliminates the danger by allowing the snow to settle in place. On small slopes and with carefully identified snow conditions, soft slab layers are sometimes stabilized by cutting them with ski tracks to relieve the tension. But this can be a hazardous occupation unless executed by experienced and safety-conscious personnel.

Occasionally, snow conditions will reach an extraordinary state of instability, requiring vigorous safety measures and control to protect lives and property in a mountain community. One instance is documented in a Forest Service report on a serious hazard situation that developed at Alta, Utah, in January, 1964.

Early winter that year brought light snowfalls alternating with extended periods of fair weather. The normal consequence of this weather pattern ensued—most of the snow cover was converted to unstable depth hoar by mid-December. Subsequent small snowfalls during the Christmas season and into January showed an alarming propensity for avalanching. The stage was set for a highly hazardous condition if a big storm arrived. One finally did on January 21.

Several periods of intense snowfall during the next three days culminated in a prolonged period that brought the total snowfall for this storm to 50 inches. Some limited artillery fire during breaks in the snowfall had already released large avalanches. On the morning of January 24, the skies cleared, but both the ski area and access highway remained closed because of avalanche danger. Just how extensive this danger was became apparent only after control measures began that same day. The heavy burden of new snow (by this time settled to a layer 36 inches thick) was almost universally too much for the fragile depth hoar to support. Huge cascades of snow were released by initial firing with artillery on those avalanche regions that most seriously endangered the ski area. One avalanche, moving at more than 100 m.p.h., was deflected beyond its normal path and struck a parking lot and ski lodge, fortunately causing only minor damage. Another, from a nearby slope, damaged a cabin and some mining equipment in its path.

This is an area where the snow ranger must plan the sequence of firing carefully, for the artillery has to be moved from point to point to fire at different targets, and some of the firing positions themselves are exposed to danger. In this instance, the final shot at the north slopes of the canyon had to be made from a position, safe under normal conditions, but exposed in exceptional cases to possible overrunning by sliding snow. The last shot brought down an avalanche that forced the gun crew to beat a hasty retreat and partially buried the 75 mm. howitzer. But it was quickly dug out and restored to service; damage had been minor.

However, the first shot directed at the opposite slopes, intended to recheck alignment of the artillery sights, started a remarkable sequence of events. Fracturing of the highly unstable stressed slabs spread rapidly from the target zone, leaping from slope to slope around the head of a large basin. One avalanche after another fell in sequence as the fracturing continued to propagate through the snow, until the disturbance had circled the entire basin, bringing an avalanche down *behind* the howitzer's position. As firing moved forward on other targets, more large avalanches fell, until practically every major slide path in the area had discharged its load of snow. Late in the day the final shot was fired at a distant slope to the west of the ski area. The fracturing that began there not only circled the head of another basin but jumped over a ridge to the next one and then to the next one beyond that, leaving behind it a trail of falling avalanches that stretched over several miles.

Highly dangerous conditions like these demand the utmost safety precautions, as well as skilled use of the artificial-release techniques for which the Forest Service snow rangers are justly renowned. A mistake can be disastrous when such impressive forces of nature stand waiting to be released at the touch of a ski or the burst of an artillery shell. But an even greater potential for disaster is the failure to understand the conditions that breed avalanches, to recognize the hazard while it is still in the developing stage. Here lies the importance of understanding the role of those changeable snow crystals that can end in avalanches.

**Alpine trees heavily coate
with rime-cemented snov
On mountain slopes simila
bonding can build up a dee
cover of snow that ma
break away as an avalanch**

Cannibalistic Revenge in Jalé Warfare

by Klaus-Friedrich Koch

In October, 1968, two white missionaries on a long trek between two stations were killed in a remote valley in the Snow Mountains of western New Guinea, and their bodies were eaten. A few days later, warriors armed with bows and arrows gave a hostile reception to a group of armed police flown to the site by helicopter. These people, described by the newspapers as "savages living in a stone-age culture," belong to a large population of Papuans among whom I lived for nearly two years, from 1964 to 1966.

People living to the west, in the high valley of the Balim River, call them "Jalé," and this is the name that I use for them. When I read of the killing of the missionaries I was reminded of how I had first heard that the people whom I had selected for ethnographic study had anthropophagic (man-eating) predilec-

Jalé warriors celebrate a battlefield triumph with a victory dance. Brilliant bird of paradise feathers punctuate the scene.

tions. After arriving at Sentani airport on the north coast, I began negotiations for transport to a mission airstrip located in the Jalémó, the country of the Jalé. "I hope the Jalé will give us permission to land," one pilot said to me. "Just a few weeks ago the airstrip was blocked because the Jalé needed the ground for a dance and a cannibalistic feast to celebrate a military victory."

Our cultural heritage predisposes many people to view the eating of human meat with extreme horror. No wonder then that the literature on the subject is permeated with grossly erroneous and prejudicial ideas about the practice. Few anthropologists have been able to study cannibalism because missions and colonial governments have generally succeeded in eradicating a custom considered to epitomize, more than any other, the alleged mental primitiveness and diabolical inspirations of people with simple technologies. However, the Jalé, completely isolated from foreign influences until 1961, still practice cannibalism as an institutionalized form of revenge in warfare, which is itself an integral aspect of their life.

The Jalé live in compact villages along several valleys north and south of the Snow Mountains in east-central West New Guinea. Until the first missionaries entered the Jalémó in 1961, the Jalé were ignorant of the "outside" world. Five years later, when I left the area, many Jalé villages still had never been contacted, and culture change among the people living close to a mission station was largely limited to the acceptance of a few steel tools and to an influx of seashells imported by the foreigners.

Two weeks after I had set up camp in the village of Pasikni, a year-long truce with a neighboring village came to an end. Three days of fierce fighting ensued, during which the Pasikni warriors killed three enemies (among them a small boy), raided the defeated settlement, and drove its inhabitants into exile with friends and relatives in other villages of the region. At that time I understood little of the political realities of Jalé society, where neither formal government nor forensic institutions exist for the settlement of conflicts.

Killed from ambush as he returned from battle, the victim, below, is carried to his funeral by members of his own village, left. The body will be cremated.

On following pages: Three-day battle culminates in plunder of an enemy village and burning of selected huts, as victorious warriors watch from a nearby ridge. After such a drastic defeat, a village is usually abandoned and open hostilities cease.

Later, when I had learned their language, I began to comprehend the conditions that make military actions an inevitable consequence of the absence of an effective system of political control.

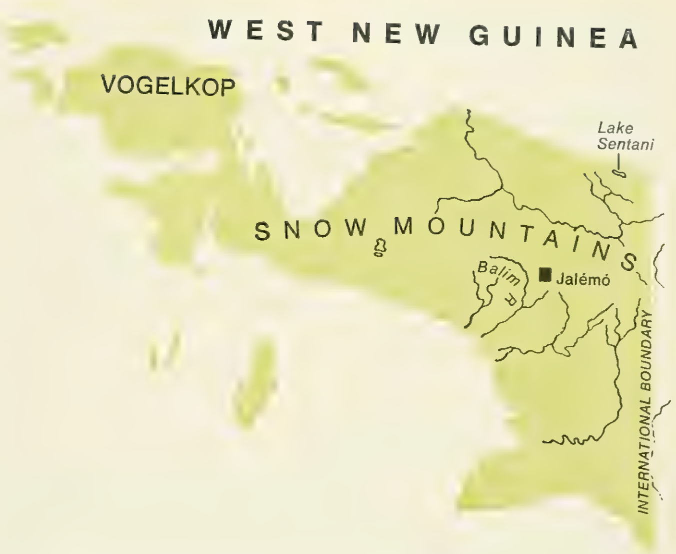
From an anthropological perspective any kind of war is generally a symptom of the absence, inadequacy, or breakdown of other procedures for resolving conflicts. This view is especially applicable to Jalé military operations, which aim neither at territorial gains and the conquest of resources nor at the suppression of one political or religious ideology and its forceful replacement by another. All armed conflicts in Jalémó occur as a result of bodily injury or killing suffered in retaliation for the infliction of a wrong. Violent redress may be exacted for adultery or theft or for a breach of obligation—usually a failure to make a compensatory payment of pigs.

Jalé warfare is structured by a complex network of kin relationships. The Jalé conceptually divide their society into two parts (moieties) whose members must marry someone from the opposite side. By a principle of patrilineal descent a person always belongs to the moiety of his father. Links between kin groups created by intervillage marriages—about half the wives in a village were born elsewhere—provide the structure of trade networks and alliance politics.

Most villages contain two or more residential compounds, or wards. One hut among the group of dwellings forming a ward is considerably bigger than all the others. This is the men's house, a special domicile for men and for boys old enough to have been initiated. Women and uninitiated boys live in the smaller huts, each of which usually houses the family of one man. The residents of a men's house constitute a unified political and ritual community, and it is this community, not the village as a whole, that is the principal war-making unit.

As in all societies, there are some individuals who have more influence over the affairs of their fellows than most. In Jalémó a man gains a position of authority (which never extends much beyond the immediate

eacherous unbridged rivers one of the obstacles Jalé must surmount revenge raids in distant lleys. Jalémó terrain mong the most gged in New Guinea.



kin group) through his acquisition of an esoteric knowledge of performing rituals and through the clever management of his livestock to the benefit of his relatives, for every important event demands the exchange of pigs—to solemnify or legitimate the creation of a new status or to settle a conflict. Most disputes are over women, pigs, or gardens, and any one of them may generate enough political enmity to cause a war in which many people may lose their lives and homes.

In every Jalé war one person on either side, called the "man-at-the-root-of-the-arrow," is held responsible for the outbreak of hostilities. These people are the parties to the original dispute, which ultimately escalates into armed combat. Being a man-at-the-root-of-the-arrow carries the liability of providing compensation for all injuries and deaths suffered by supporters on the battlefield as well as by all others—including women and children—victimized in clandestine revenge raids. This liability acts as a built-in force favoring an early end of hostilities.

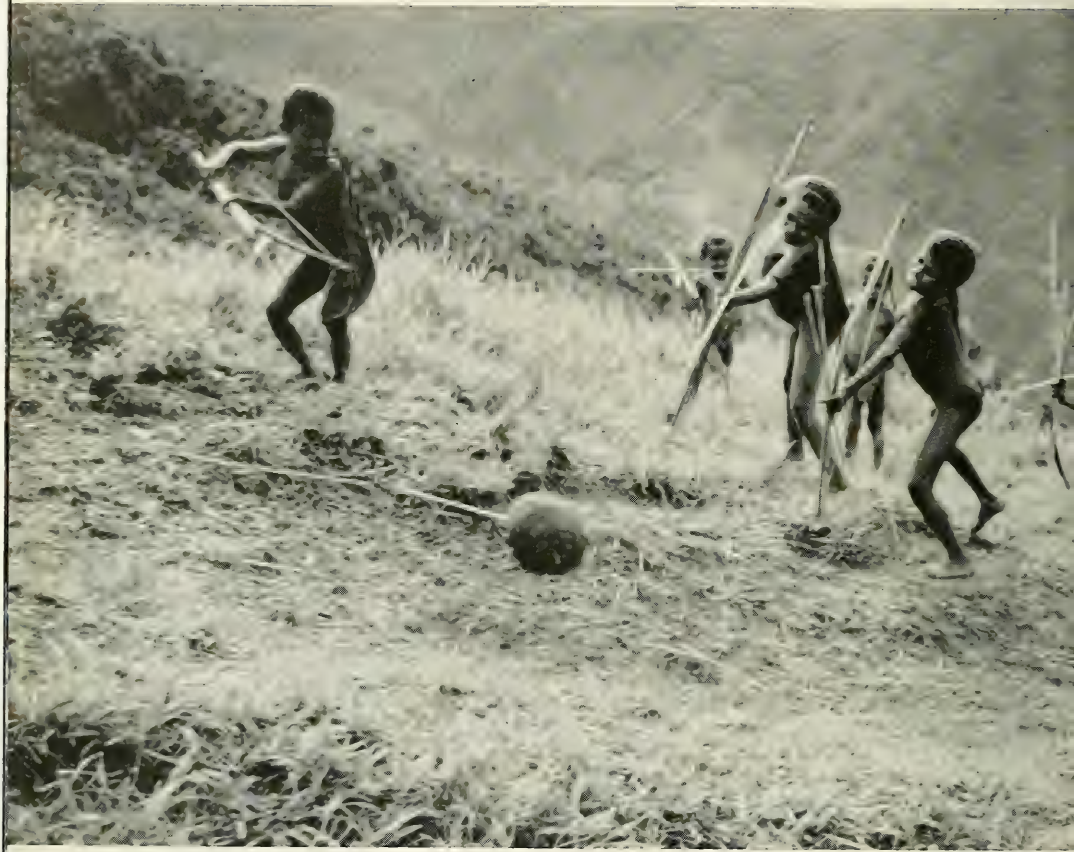
On rare occasions blood revenge has been prevented by delivery of wergild compensation, in the form of a pig to the kinsmen of a slain person. But only those people who, for one reason or another, cannot rally support for a revenge action and who shy away from solitary, surreptitious ambush attacks will accept such an offer if it is made at all. A negotiated peace settlement of this nature is most likely if the disputants are from the same village or if the whole settlement is at war with a common outside enemy.

When two villages are at war with each other, periods of daily combat are interrupted by short "cease-fires" during which the warriors attend to the more mundane task of garden work, but they are always prepared to counter a surprise attack launched by the enemy. After several weeks of discontinuous fighting, however, the threat of famine due to the prolonged neglect of proper cultivation induces the belligerents to maintain an informal and precarious truce. During this time small bands of kinsmen and members of the men's house of a victim whose death could not be avenged on the battlefield will venture clandestine expeditions into enemy territory, from which a successful raiding party may bring back a pig as well. It is a revenge action of this kind that often precipitates a resumption of open warfare.

Fighting on the battlefield follows a pattern of haphazardly coordinated individual engagements, which rely on the tactic of "shoot-and-run." This technique requires a warrior to advance as far as the terrain affords him cover, discharge an arrow or two, and then run back to escape from the reach of enemy shots. When one side has been forced to retreat to its village, the fighting turns into sniping from behind huts and fences. Women and children always leave the village if an invasion is imminent and take refuge with friends and relatives in other villages. As a last resort the men retreat into the men's house, which a taboo protects from being burned. When a battle reaches this stage, the victorious warriors often plunder and burn family huts. Following a catastrophe of this extent the defeated side usually elects to abandon their village, and the warfare ceases, but the hostilities linger on until a formal peace ceremony reconciles the principal parties. Arranging the ceremony, which features the ritual slaughter and consumption of a pig, may take years of informal negotiations between people who have relatives on both sides. Afterward, dances in both villages and pig exchanges on a large scale consolidate the termination of the conflict.

"People whose face is known must not be eaten," say the Jalé. Consequently, cannibalism is normally not tolerated in wars between neighboring villages, and the few incidents that did occur during the lifetime of the oldest Pasikni men are remembered as acts of tragic perversion. In wars between villages separated by a major topographic boundary such as a mountain ridge, however, cannibalistic revenge is an integral part of the conflict.

While territorially confined hostilities usually end within a few years, interregional wars may last for more



By the time these young boys become warriors, they will be expert archers. Training begins early; boys who can hardly walk carry bows made by their fathers. Practice games, above, perfect the proper stance.

A Jalé man carefully aims his arrow at a pig's heart. Most socially important events—especially marriages, initiations, and dances—require the sacrifice of a pig.

than a generation. During this long period revenge parties from either side venture sporadic expeditions into hostile areas, keenly avoiding any confrontation in battle and seeking instead to surprise lone hunters or small groups of women working in distant gardens. The geography of interregional wars favors long-lasting military alliances that have a stability quite unlike the temporary and shifting allegiances that personal kin connections and trading partnerships create in local conflicts.

If an enemy is killed during a foray into hostile territory, the raiders will make every effort to bring the body home. If tactical exigencies demand that the revenge party retreat without the victim, an attempt is made to retrieve at least a limb. The avengers always present the body to an allied kin group that has lost a member in the war. In return they receive pigs and are feted at a victory dance, during which the victim's body is steam-cooked in an earth oven dug near the village. Before the butchering begins, the head is specially treated by ritual experts: eyelids and lips are clamped with the wing bones of a bat to prevent the victim's ghost from seeing through these apertures. Thus blinded, it will be unable to guide a revenge expedition against its enemies.

After the head has been severed, it is wrapped in leaves. To insure more revenge killings in the future, some men shoot reed arrows into the head while it is dragged on the ground by a piece of vine. Then the head is unwrapped and swung through the fire to burn off the hair. This is accompanied by loud incantations meant to lure the victim's kinsmen into sharing his fate.

Following this ritual overture the butchers use stone adzes and bamboo knives to cut the body apart. The fleshy portions are removed from the skull, and in an established order of step-by-step incisions, the limbs are separated from the trunk, which is split open to allow removal of the gastronomically highly prized entrails. Some small, choice cuts, especially rib sections, are roasted over the fire, but the bulk of the meat is cooked with a variety of leafy vegetables.

Before and during the operation, people who are preparing the oven, tending the fire, or just standing around appraise the victim. A healthy, muscular body is praised with ravenous exclamations, but a lesser grade body is also applauded.

When the meat is done, the pit is opened and the "owners of the body," as the Jalé call the recipients of a slain enemy, distribute much of the food among the attending relatives of the person whose death the killing has avenged. It is also distributed to the allied kin groups of a person maimed or killed in the war. Eligible people from other villages who could not participate in the celebrations are later sent pieces reserved for them. If mood so moves the Jalé, they may place some of the victim's bones in a tree near the cooking site to tell travelers of their brave deed.

In the course of the dancing and singing, a poetically gifted man may introduce a new song. If the lyrics appeal to others, it becomes a standard piece in the repertoire. The songs commemorate fortunate and tragic events from past wars, and a typical verse goes like this:

Ngingi, your mother
bakes only tiny potatoes for you.
Isel, your mother too
bakes only the ends of potatoes
for you.
We shall bake big potatoes for you
On the day of Kingkaen's return.

Ngingi and Isel are the names of two men from a hostile village, the home of a young woman named Kingkaen who was killed in an ambush attack in September, 1964. The lines make fun of the men who, because of Kingkaen's death, have to eat poor food prepared by the inept hands of senile women.

When the festival of revenge is over, the members of the men's house group of the owners of the body arrange for the ritual removal of the victim's ghost from their village. Rhythmically voicing efficacious formulas and whistling sounds, a ceremonial procession of men carries a special arrow into the forest, as far into enemy territory as is possible without risk. A small lump of pig's fat is affixed to the arrow by an expert in esoteric lore. (Pig's fat used for ritual purposes becomes a sacred substance that is applied in many different contexts.) The arrow is finally shot toward the enemy village. This, the Jalé believe, will make the ghost stay away from their own village, but as a further precaution they block the path with branches and plants over which spells are said.

Protective rites of this kind, and the vengeance ritual described above, are the only aspects of Jalé cannibalism that may be viewed as "religious." The actual consumption of human meat and organs does not constitute an act with intrinsic "supernatural" effects. Instead, as my Jalé friends repeatedly assured me, their reason for eating an enemy's body is that man tastes as good as pork, if not better. And they added that the bad enemies in the other valley had eaten some of their people.

These descriptions of Jalé rituals and beliefs do not sufficiently explain the practice of cannibalism. To do so would necessitate the compilation of all available information about this custom from every part of the world. On the basis of these data an extensive study would have to be made of the ecological and cultural variables found to be associated with institutionalized cannibalism. Perhaps it would then be possible to recognize specific ecological and sociological features that appear to be correlated with the consumption of human meat, but the task of interpreting the custom as a sociopsychological phenomenon would still remain.

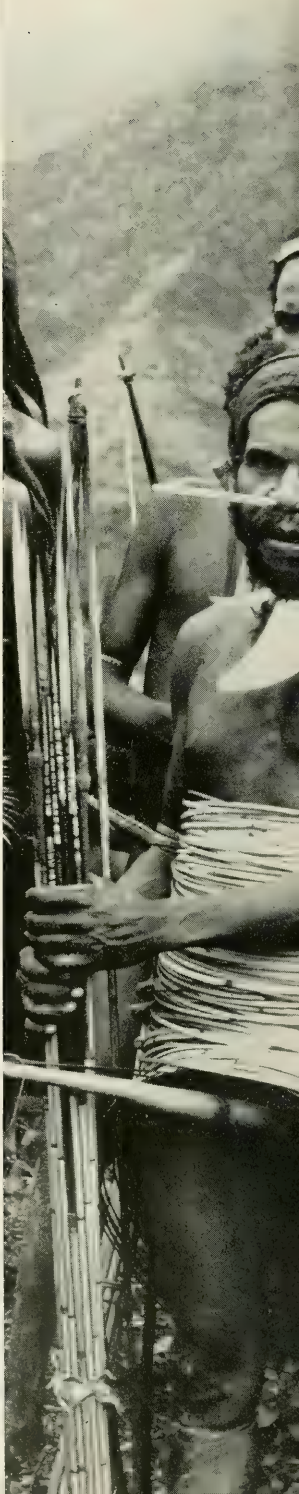
It is obvious that the enigmatic nature of cannibalism has invited many writers to speculate about its origin and its biopsychic basis. Aristotle attributed anthropophagy among tribes around the Black Sea to their feral bestiality and morbid lust. In 1688 a treatise was published in Holland entitled *De natura et moribus anthropophagorum* ("On the Nature and Customs of Anthropophagi"), and some ethnographers writing in the nineteenth century still regarded the rejection of cannibalism as the "first step into civilization." Certainly, the consumption by man of a member of his own species is as much a problem for evolutionary bioanthropology as it is for ethnology and psychology. I have made an extensive survey of the various theories proposed by earnest scholars to elucidate the phenomenon, and I have found that, at best, a few hypotheses appear plausible for the interpretation of certain aspects of some cannibalistic practices.

In Jalémó the eating of a slain enemy, in addition to its dietary value, certainly indicates a symbolic expression of spite incorporated into an act of supreme vengeance. Violent retaliation, in turn, must be seen as a consequence of certain sociopsychological conditions that determine the degree of aggressive behavior expected and tolerated in their culture. Cross-cultural studies by anthropologists have supported theories that are applicable to Jalé society. An accepted model of personality development demonstrates that societies in which boys grow up in intimate association with their mothers, who dominate a household situation in which the boy's male elders, especially their fathers, do not take part, are characterized by a high level of physical violence. Sociological models developed from large-scale comparative research predict that in societies in which small kin groups operate as relatively independent political units, warfare within the society is a common means of resolving conflict.

Both models squarely apply to Jalé society. First, young boys, separated from the community of the men's house until their initiation, are socialized in a female environment. Second, the wards of a village are not integrated by a centralized system of headmanship, and no political cooperation exists between them until they are threatened by, or faced with, actual hostility from other villages. These are the critical variables that partially determine the bellicosity and violence I have observed.

No specific hypothesis can be given to explain the cannibalism that the Jalé incorporate in their vengeance. It is certain, however, that no understanding can be achieved by applying precepts of Western thought. In a missionary's travelogue published seventy years ago, the author, speaking of an African tribe, recounted:

> Once, when told by a European that the practice of eating human flesh was a most degraded habit, the cannibal answered, "Why degraded? You people eat sheep and cows and fowls, which are all animals of a far lower order, and we eat man, who is great and above all; it is you who are degraded!"



Several hundred loops of split liana vine are worn by Jalé men day and night. As an expression of masculinity, younger men wear more loops than their elders. Penis sheaths, cut from gourds, are tied around the body.

THE EGG MACHINE

by Pamela Tyler Lindstrom

The female sea urchin can be relied upon to produce about one million eggs per season, a capacity that delights embryologists

Sea urchins are round, hard, spiny, abundant, shallow-water marine invertebrates that do little but eat seaweed. Their enemies are few—sea otters (who crack them against rocks held on their stomachs), starfish, and, perhaps, embryologists. Mediterranean people eat them, but only embryologists carry off so many that they have endangered a whole population of sea urchins—*Arbacia punctulata*—at Woods Hole, Massachusetts.

Embryologists don't realize that their interest seems peculiar to others, for their use of sea urchin eggs is deeply embedded in their tradition. But when they go collecting, they expose themselves to the public, and people watching them always ask the same question: "Who cares about *their* embryos? Why don't you find out about people instead?"

The embryologist will point out the difficulty of doing physiological experiments on people. But since he, too, wonders about the fitness of things, he may ask himself: Why not dogs, cats, frogs, goldfish, or earthworms? Scientists study the behavior, embryology, physiology, and distribution of all animals, not only sea urchins, yet more is known about the developing sea urchin egg than about any other. There are whole laboratories that study little else.

Why sea urchin eggs? Well, what is a sea urchin egg? Herein lies the whole lure of embryology because an egg, any egg, is just a cell. Its internal structure is not unlike that of other cells. If left alone an egg runs down and dies in a few hours. But when it encounters a sperm of its own species—then without hesitation, without any instructions but those inside it, and usually without error—the egg develops into a completely new creature. From the apparently simple mass of an egg comes a beast of many parts. From a single cell come not only more cells, but different kinds of cells.

Now, common sense, as well as the second law of thermodynamics, forbids orderly complexity to arise from simplicity. During the second half of the nineteenth century, scientists overcame their awe of all this complexity and began to ask questions. The first embryologists asked, "What happens, in detail?"

Late in the nineteenth century several German embryologists, using sea urchin eggs, recorded fertilization for the first time. They saw the sperm enter the egg, then the sperm and egg nuclei fuse. They used the eggs of sea urchins because the animals are easy to find, easy to catch, and easy to rob of eggs and sperm. Their eggs are not only abundant (a female may produce one million per season) but they are also of the proper size and clarity for viewing the meeting of egg and sperm through a microscope. Embryologists have since then seen this event in many types of eggs. (Fertilization of human eggs, for instance, was first seen last year. No one was surprised that it is basically the same as fertilization of sea urchin eggs.)

The clear sap of the sea urchin egg allowed the pioneers to watch mitosis. In that process, immediately after fusion of the sperm and egg nuclei, the chromosomes in the combined nucleus are arranged in two identical sets. The egg divides into two cells, each containing a complete set of chromosomes. More cell divisions turn the egg into a clump of several hundred cells. This clump develops a hollow center (blastula stage). To visualize the next step, imagine poking your finger into the wall of a balloon until your finger reaches the wall on the other side. Then the turned-in balloon on your fingertip touches and fuses with that wall, and a hole appears through the point of fusion. Thus the embryo becomes a sphere with a tube through it, a gastrula.

The tube becomes the gut, the embryo grows hairlike processes on its surface for swimming and develops a primitive skeleton and nervous system. Then it begins feeding.

Development is simple and fast because sea urchins reproduce according to the theory that one should make as many eggs as possible, each with a minimum of yolk for nourishment. Then they all shed eggs (and sperm) into the water at the same time, eschewing further responsibility. Some eggs will be fertilized and enough will grow up to continue the species. The egg, of course, has to turn itself into a feeding larva quickly before it runs out of yolk. In contrast, land and freshwater invertebrates and vertebrates, with the exception of most fishes, produce relatively few eggs, which they then protect from their harsh environment—birds, for example, make eggs with substantial yolk and shells and female mammals carry their young inside their bodies.

Although the embryos of sea urchins, which develop by the first method, are easier to obtain and see, pre-1900 embryologists watched many kinds. They found that different embryos follow several different patterns of development, and that each requires study. The early events through gastrula formation are remarkably similar, however, and sea urchin development looked like a good model for all the rest.

About 1900, embryologists realized that their observations had merely revealed new depths that needed to be probed. Sperm almost always attach to eggs of their own species—but embryologists knew of no mechanism that would explain this. Nor did they know the exact roles of egg and sperm in producing the new animal. They began the still-continuing search for the "trigger," the event at fertilization that leads to all the other events. Organized cell movements puzzled them—in every embryo, for instance, the same cells move inward at the same time to form the gastrula. Why, they asked, such elaborate procedure to give each daughter cell a complete set of chromosomes?

Later the question of how differentiation occurs came to dominate embryology. Although the cells of the blastula look alike, do they perhaps already differ chemically? With such questions the era of experimental embryology began, and most researchers used sea urchin eggs for their experiments.

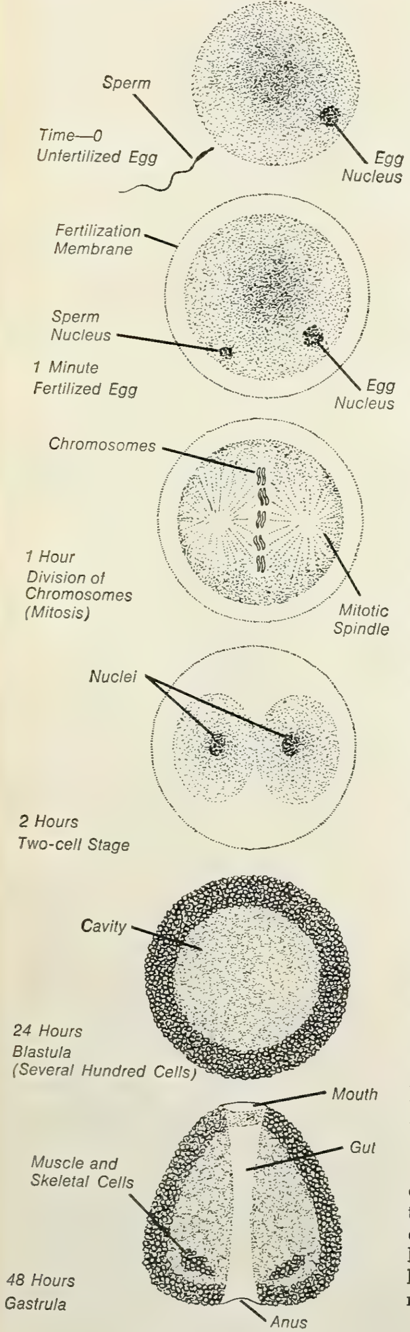
One embryologist divided the cells of a two-celled embryo. Each cell grew into a normal larva, as did each of the cells of a four-celled embryo; but the cells of an eight-celled embryo did not. These cells must differ from one another, each containing, not the pattern for a whole larva, but only the pattern for part of a larva. But we still do not know precisely how one cell of an 8-cell embryo differs from its other cells.

Another embryologist pricked mature unfertilized eggs with a needle. Some acted as if a sperm had fertilized them and grew into normal larvae. Cynics decided that the sperm was useful only to insure that all offspring would not be identical to the mother.

Another caused the eggs to divide abnormally, so that the daughters did not get the proper chromosomes. All the larva were abnormal. Geneticists soon confirmed this, and found in addition that not only every chromosome but almost every gene is necessary for a normal embryo and a normal animal. Another found that a molecule, which he called fertilizin, in the egg's external coat, reacted with a molecule on the surface of sperm of the same species. He compared this to antibody-antigen reactions and believed he had located the point at which sperm-egg attachment is species-specific.

Still another embryologist developed a machine that could measure the oxygen uptake of a few eggs. He found that oxygen uptake, reflecting the metabolic rate, increased at fertilization. He noted changes in rate that coincided with other important events in the embryo's career. These metabolic data entered the dogma of embryology, as did the results from many other experiments with sea urchins. It was years before someone found that not only were the data not characteristic of all embryos, they were not even true for all species of sea urchins. However, the overgeneralization does not detract from the discovery that visible events during development seem to be manifestations of metabolic, that is, biochemical events, and that even before they become visible, events can be detected in the metabolism of the embryo.

EARLY DEVELOPMENT OF SEA URCHIN EGG



A great many experiments over 30 years revealed a great many metabolic changes. The first general theories of embryonic development were based on these results.

The axial gradient theory came from sea urchin work, and the induction theory from vertebrate work. Adherents of both sought proof for a chemical explanation and failed. The two "general theories" never made contact; embryologists now know too much to expect that all the phenomena of cellular development will be explainable in terms of any single phenomenon.

Meanwhile, embryologists, insatiably hungry for detail, were measuring each aspect of sea urchin eggs. They measured amount of protein per egg, amount of deoxyribonucleic acid (DNA) per egg, amount and variation among the polysaccharides, relations between ATP and ADP, activity of many enzymes; and how these varied among the species and during development. Each measurement added another reason for embryologists to use sea urchin eggs in experiments. There is not now, and probably never will be, any other egg known in such metabolic detail.

But embryologists found no guiding principle in all the detail. They still asked, what tells cells to differentiate? What is the basic event in becoming different? Some embryologists had long realized that the genes played a large part in development. Pioneers at the beginning of the century showed that the egg and each cell of the embryo needed a nucleus with all its chromosomes for normal development. No experiments on the action of genes could be done until quite recently. That genes control synthesis of proteins was discovered in fungi about 1940. About that time the study of protein synthesis in egg and embryo began. The theory of the actual mechanism by which genes make proteins began in 1953, and is still being studied.

Study of the sea urchin egg and embryo along these lines has come to occupy the mainstream of embryology. Some sea urchin work has been checked by using other eggs, but only amphibian eggs have given much additional information.

We begin to picture the unfertilized egg as "turned off," but ready to start developing. Fertilization seems to remove all the egg's inhibitions. Various enzymes become active. More important, the inhibition of protein synthesis is removed.

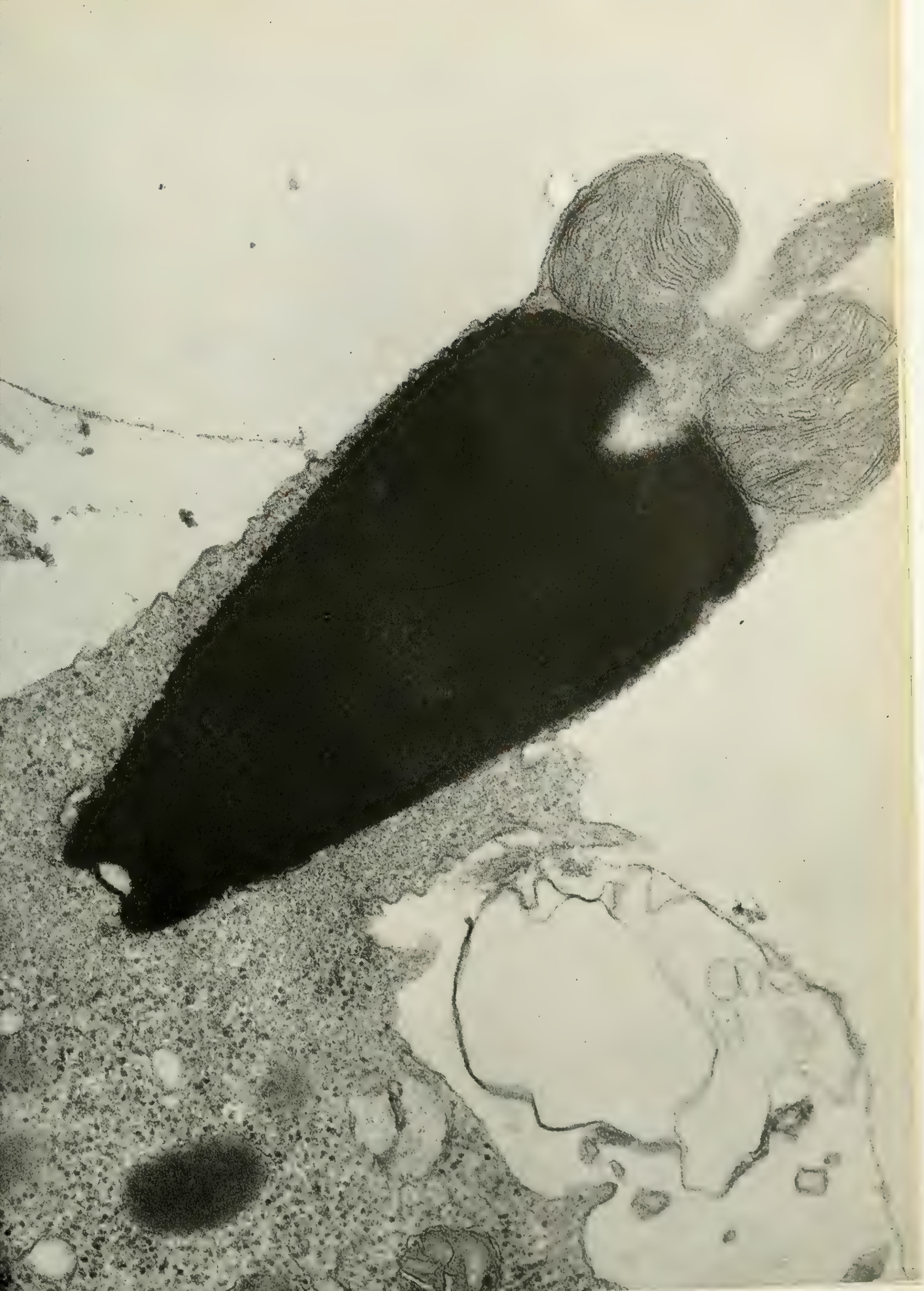
Short-lived ribonucleic acid, "messenger RNA," is the intermediate between the genes and the cell's protein-making machinery. It was found that even when the mRNA-making machinery was poisoned at fertilization, early development into a blastula took place normally. To explain this, embryologists proposed that "masked messenger RNA" is already present, but inhibited, in the unfertilized egg. It needs only to be released ("unmasked") at fertilization. This is the mRNA that determines the composition of the proteins that are made during development—up to gastrulation. New mRNA is normally made by the fertilized eggs and may be "masked" until needed to direct the synthesis of the new kinds of proteins needed for gastrulation. A cleaving embryo unable to make mRNA cannot gastrulate, even though it may seem to develop normally up to that time.

The course of RNA synthesis during later development is both complicated and a source of controversy. So is the identity of the new proteins made to the direction of the mRNA synthesized after fertilization. Except for proteins of the cell-dividing apparatus, no new ones have been isolated from the early embryo. No doubt new enzyme proteins are made, but so few molecules of each that they cannot be detected yet.

Why has so much embryology come from sea urchin eggs? In the beginning, because they were easy to work with; at later stages, the early work provided a good foundation for more advanced study.

This is where embryology stands today, closer to the deep secrets of the embryo, and perhaps, at last, with the right tools for attacking these secrets.

Sea urchin fertilization: this remarkable electron micrograph depicts the penetration of an egg by a sperm. Magnification is 50,000×.



THE EVOLUTION

The ability to sleep distinguishes mammals and birds from lower orders. The kind of sleep reveals much about an animal's life style

by Truett Allison
and Henry Van Twyver

Field mouse

Macaque monkey

)F SLEEP

For most of us, sleep is a seemingly empty void except for an occasional remembered dream and a rested feeling after a night of slumber. This subjective impression is only partly correct. Each night, four or five times at intervals of about 90 minutes, the quiet repose of human sleep is interrupted by a curious set of physiological and mental events: A dream begins and develops its own inner logic. The dream narrative does not flash through the mind almost instantaneously, as was once commonly thought, but proceeds in "real time" with a duration about as long as the events would actually require. During the dream, the nervous system and bodily functions are very different from those of the preceding, nondreaming sleep. Heart rate and respiration become irregular, and the eyes move as if following the dream events. Muscular twitches of the hands or limbs occur, but otherwise the dreamer is still.

"Dreaming" sleep is not confined to *Homo sapiens*; based on laboratory studies, it is clearly present in many lower animals such as monkeys, cats, dogs, and rats. For these animals, however, we use a more cautious term—paradoxical sleep—to describe their apparent dream-sleep.

The concept of sleep, viewed in terms of both humans and lower animals, raises a number of important questions: If animals exhibit the symptoms of dream-sleep, do they actually dream? In what sort of animal did this type of sleep first arise, and for what reason? Is dreaming, and all the physiological changes that accompany it, a necessary biological event or, as Freud suggested, simply a means for satisfying psychological needs?

Through studies conducted by many investigators during the past fifteen years, we can provide tentative answers to these questions. Of the numerous species of living animals, the sleeping states of less than three dozen mammals and even fewer nonmammals have been studied in the laboratory. Still, enough is known to indicate the broad outlines of a story that takes us back almost 200 million years, to the time when mammals first appeared on earth. Lacking the opportunity to go back in time to observe the first mammals, we, and other investigators, have studied the sleep of certain living mammals that approximate critical stages of mammalian evolution in order to determine how these first mammals slept—and perchance dreamed.

How do we decide when an animal is sleeping? At first, this probably sounds like no problem at all: simply look at the animal and observe whether it is active or lying quietly, whether the eyes are open or closed. What would we say, however, in the case of a horse or cow, which seldom closes its eyes, or a fish or snake, which cannot? Humans as well as some other mammals have also been known to sleep with one or both eyes partially open.

Thus, casual techniques of observation are often not an objective means of telling when an animal is awake or asleep. Instead we use the electroencephalograph, or EEG machine, an electronic instrument used in hospitals to record the electrical activity of the brain. It consists of several very sensitive amplifiers that magnify the extremely small voltages generated by brain nerve cells. In humans these signals are detected by electrodes attached to the scalp, and the brain activity is recorded by an ink-writing pen on a moving paper chart. In animals brain activity can be recorded in the same manner, and with certain modifications of the machine, other physiological processes—such as breathing, heartbeat, and muscle activity—can also be recorded. To measure these physiological events, the animal is anesthetized and fine wires are placed in various regions of its brain and body. When the animal has recovered from the implantation, the electrodes are connected by cable to the EEG machine, which then records the changes that occur during waking and sleep. After implantation the animals are normal and do not appear to notice the electrodes or cables.

Typical EEG recordings during a cat's waking and sleep states appear on page 59. The tracings on the left were made while the animal was sitting quietly. Small electrical charges generated by the movement of the eyes were recorded by electrodes placed around the eyes. In the example shown there are two eye movements about four seconds apart. The electrical activity from the cerebral cortex, or gray matter, shows many small, fast fluctuations. (The cortex is nonexistent in reptiles. Increasingly prominent in higher mammals, it is believed to underlie complex mental functions.) The next tracing was taken from the hippocampus, an area deep within the brain involved with memory, whose electrical emanations accurately reflect changes in arousal. When the animal is alert and exploring its surroundings, nerve cells in the hippocampus tend to discharge electrical impulses in synchrony at the rate of several bursts per second, giving the record a rhythmic, wavelike appearance. Several such waves can be seen in the left-hand portion of the tracing. The third tracing shows electrical activity recorded from the neck muscles. During the waking state these are constantly active to support the head, resulting in large, rapid fluctuations recorded as a thick, ragged line.

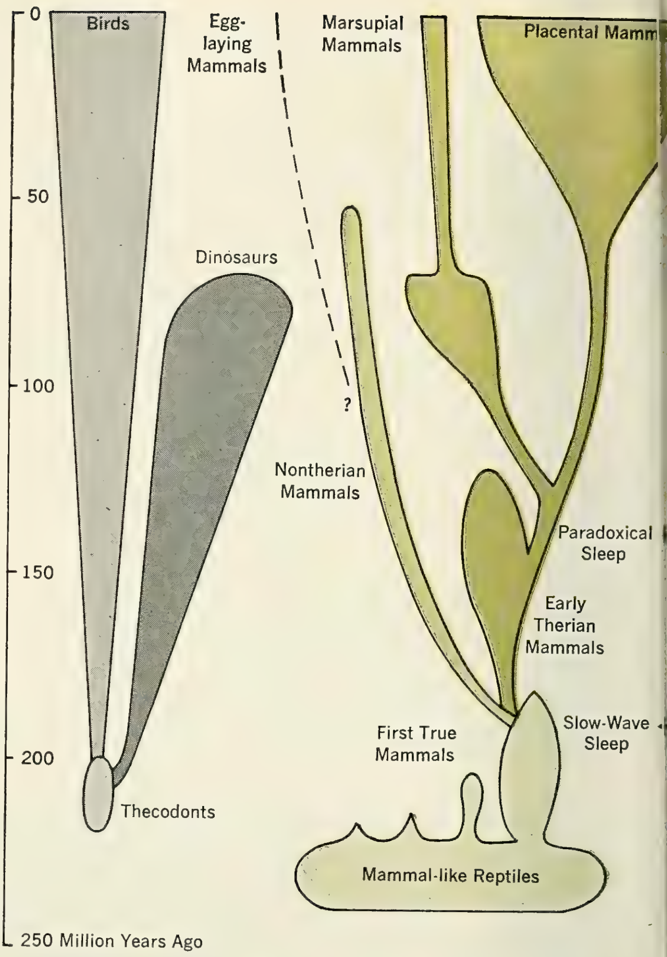
When the cat goes to sleep (middle section), muscle tone is reduced but still present. Large eye movements cease, although there may be occasional slow, rolling movements. The activity of the brain is now markedly different. Large, slow waves, indicating the synchronous activity of many nerve cells, are recorded both in the cerebral cortex and the hippocampus, hence the name slow-wave sleep.

After several minutes of slow-wave sleep, the cat then passes fairly rapidly—the transition takes only a few seconds—into paradoxical sleep. Now a number of physiological events occur. Many of these—such as twitching and eye movements—are visible to an observer. Others can only be seen with the aid of the EEG machine. Eye movements, either singly or in bursts, appear and continue sporadically during the paradoxical sleep episode. The eye movements occur more often and are jerkier than during waking. Electrical activity of the brain is similar to that during waking. Indeed, the hippocampus waves are even more rhythmic than when the animal is very alert. All these signs indicate an alert waking brain, but clearly the animal is not awake, for now muscle tone has disappeared completely; the cat is limp and difficult to arouse. It is this discrepancy between what appears to be a waking brain and a deeply sleeping body that led Michel Jouvet of the University of Lyons, France, to coin the term paradoxical sleep. This state has also been called rapid eye movement, or REM, sleep. But since this phase of sleep occurs also in animals that rarely or never move their eyes we prefer the term paradoxical sleep.

In mammals these EEG signs of sleep are very clear, but in submammalian forms such as amphibians and reptiles, EEG recordings may not be adequate to define sleeping and waking periods because the animals have relatively undeveloped brains. In the lower animals, behavioral criteria are also necessary; sleep is defined as a period when the animal is quiet and less responsive to stimulation.

We begin our analysis of the evolution of sleep with the bullfrog and salamander, lowly amphibians that mark the point of transition from sea-dwelling to land-dwelling vertebrates. Both EEG and behavioral criteria indicate that they almost certainly do not sleep. Instead they alternate between periods of quiet and active wakefulness.

In reptiles, which evolved from amphibians, the presence of sleep is not clear-cut. Conflicting results have been reported by different investigators. As in amphibians, there are periods during which the animal is quiet and immobile but still essentially awake. If reptiles sleep at all, they have only the rudiments of sleep as compared to mammals.



During cold weather both amphibians and reptiles retreat to secluded places where they remain completely inactive until warm weather resumes. These periods of torpidity also occur in some familiar mammals such as bears.

Interestingly, both stages of sleep—slow-wave and paradoxical—are found in birds. In chicks and pigeons, small amounts of paradoxical sleep can be observed and a clear stage of slow-wave sleep is evident.

With some variation from animal to animal and from species to species, both kinds of sleep have been found in all higher mammals studied in the laboratory. So far, the list includes, in addition to humans of all ages, the chimpanzee and several other primates, various rodents, hedgehogs, bats, sheep, and goats—even the pilot whale. Visual observation of elephants at the Boston Zoo suggests that they too have paradoxical sleep. Since paradoxical sleep is present in animals as different in size as mice and elephants, and as different in life styles as bats and goats, it is probably safe to say that all higher animals have both slow-wave and paradoxical sleep. Given that sleep is probably not present in reptiles, but clearly present in mammals and birds, at what stage of mammalian evolution did sleep arise?

The diagram above summarizes

s phylogenetic tree
ımarizes the evolution of
ıe reptile groups and their
cendants. In the mammalian
nch, slow-wave sleep
ıarently had evolved by the
e noted by the first arrow.
adoxical sleep arose some
e after, but probably no
r than the time indicated
the second arrow.

the probable evolution of mammals as it is presently understood by paleontologists. About 220 million years ago the most abundant land vertebrates were a diverse group of advanced reptiles, which had in some respects almost reached the mammalian level of development. The first true mammals, small creatures resembling shrews in appearance—and perhaps in behavior—descended from one of these reptilian groups about 180 million years ago.

All the later mammals probably derived from early mammals similar to this shrewlike creature. One group of descendants, the therians, eventually gave rise to the two main kinds of living mammals, the marsupials and the placentals. A second group, the nontherians, became extinct many millions of years ago with the exception of two that still survive, the platypus and the echidna. These remarkable animals are now found only in Australia and nearby islands, where they have survived because these geographically isolated islands were until recently inhabited only by relatively docile marsupials. Placental mammals tend to displace less cunning and aggressive neighbors.

The living nontherians—platypus and echidna—are hairy, maintain a constant body temperature, and nurse the young. They are therefore unquestionably mammals, even though they have retained a number of reptilian features, the most striking of which is that the young are hatched from eggs. These two egg-laying mammals seem to have changed little (except perhaps in external appearance) since they first evolved. They provide the opportunity to study sleep as it appeared in the first mammals.

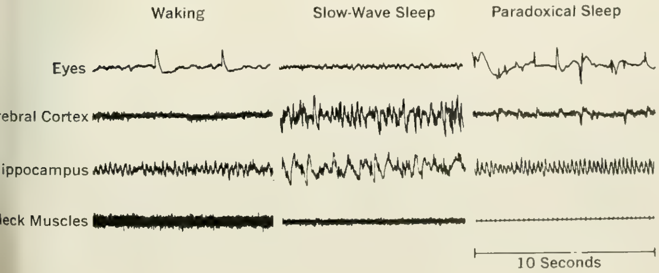
The platypus is difficult, if not impossible, to keep in captivity. The echidna, however, adapts readily to laboratory conditions. We obtained several echidnas through the cooperation of Mervyn Griffiths of the Commonwealth Scientific and Industrial Research Organization in Canberra and were able to study their sleep habits in detail. We found that this animal sleeps a great deal, up to twelve hours a day, and that its sleep is all slow-wave. We have not detected a single episode of paradoxical sleep. Instead the EEG reveals quiet periods that in many ways resemble the resting periods of reptiles. Because paradoxical sleep had been seen in all other mammals studied, we had expected to find it in the echidna as well.

It is possible that we were not able to see paradoxical sleep because its physiological and nervous system manifestations are radically different in primitive mammals. To test this possibility we studied sleep in another primitive mammal, the opossum. This marsupial, which has been called a living fossil, appears to have changed little since it first evolved. Just as the echidna gives us the best picture of earliest nontherian mammals, the opossum gives the best picture of early therian life. As it turns out, both slow-wave and paradoxical sleep are present in the opossum and are entirely similar to these states in placental mammals. The opossum revealed that paradoxical sleep is much the same in any mammal in which it is present at all, no matter how primitive the creature.

With this finding we then checked the hypothesis that paradoxical sleep is absent in the echidna because the animal is highly specialized in its life style, and not because it is primitive. To test this possibility we needed a placental mammal specialized, like the echidna, as a digging animal that spends considerable time underground and consequently has poor vision. We decided that the common mole would provide the best comparison. Even more adapted to life underground than the echidna, and like other animals that live in darkness, the mole's visual system has degenerated. The mole should therefore serve admirably as an "advanced echidna."

Moles, we found, are perfectly normal mammalian sleepers. Their slow-wave and paradoxical sleep, as measured by the EEG, are typical of that seen in other placental mammals and in the opossum. Like humans, moles sleep about eight hours a day; about one-fourth of this is paradoxical sleep. Furthermore, the electrical activity of their brain during sleep is similar to that of man.

These findings indicate that the lack of paradoxical sleep in the echidna is probably due to its primi-



These electrical recordings, made from a cat in its waking state and during two states of sleep, show that the pattern of activity in each state is clearly different. Recordings taken from other animals during the same states would look very similar.

THE DREAM WATCHER'S GUIDE

Although episodes of "dreaming," or paradoxical, sleep can be determined most accurately in the laboratory, it can also be seen in animals found around the house, such as dogs, cats—and children. Indeed, its signs are so clear that, in retrospect, it is surprising that this kind of sleep was discovered less than twenty years ago.

In cats and dogs, watch for this sequence of events: When the animal first goes to sleep, "nondreaming," or slow-wave, sleep always occurs first. Respiration is fairly regular and slow. Bodily movements are infrequent and the animal is still and quiet. After a period of ten to twenty minutes the first paradoxical sleep period begins. Now the eyes can be seen moving under the eyelids, which may be partially open. Breathing is irregular rapid, shallow breaths alternating with periods of breath holding. The ears and whiskers twitch, often accompanied by facial twitches and grimaces. The paws may twitch, occasionally in synchrony as if the animal were trying to run.

In children the signs of paradoxical sleep are much the same except that facial movements often include sucking movements. In babies a paradoxical sleep episode may directly follow feeding.

The frequency of paradoxical sleep varies according to body size, from about every nine minutes in the mouse, to fifty minutes in the monkey or child, to ninety minutes in adult humans.

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tive mammalian status, not to its particular way of life. We can judge by the echidna then that slow-wave sleep was present in the first true mammals, and thus had probably evolved in its present form about 180 million years ago.

Since paradoxical sleep is virtually identical in the marsupials and placentals it was probably present in their common ancestor among the early therian group. It is unlikely that paradoxical sleep evolved independently in both groups at some later time. If this reasoning is correct, paradoxical sleep probably evolved in its full-blown mammalian form about 130 million years ago, or as much as 50 million years after the development of slow-wave sleep.

This evolutionary history of sleep is somewhat speculative, since we are inferring from living animals events that took place in the distant past. There are, however, two types of investigation that could lend further credence to the sequential development of sleep—from nonsleep to slow-wave to slow-wave plus paradoxical sleep. One study would involve platypus research. If we found only slow-wave sleep in this animal, which came upon earth at about the same time as the echidna, it would support the hypothesis that paradoxical sleep evolved at a later stage of evolution. Because it appears impossible to study the platypus in the laboratory, tiny devices would have to be implanted under its skin to transmit EEG information to distant receivers, as is done with astronauts. The advantage of telemetry, as this method is called, is that the animal is free to live in its natural habitat.

In principle, a second way of testing the idea that slow-wave sleep and paradoxical sleep arose sequentially is to look at different birds that approximate critical stages of avian evolution. So far as can be determined from the scanty fossil record of birds, all living forms are relatively recent. There appear to be no really primitive forms comparable to the echidna and opossum. However, the appearance of both phases of sleep in birds does show that, just as birds and mammals independently evolved a four-chambered heart from the three-chambered variety of their reptile ancestors, both phases of sleep evolved independently at least twice (in birds and in mammals) in the course of vertebrate evolution. There may have been transitional avian species, therefore, which displayed slow-wave, but not paradoxical sleep.

What do these findings tell us about the biological role of sleep? The descendants of reptiles—the mammals and the birds—have two things in common: they both sleep, and they both maintain constant body temperatures despite changes in environmental temperature. The ability of mammals and birds to be active at any temperature is a distinct advantage over the reptiles, which become sluggish in cool weather. A disadvantage of this mechanism, though, is that a great deal of food is required to keep the bird or mammal body warm; it would be advantageous to turn down the body's "thermostat" when the stomach is full or danger is not imminent.

A clear example of this benefit of lowered body temperatures during sleep is provided by comparing shrews and bats. Both are small mammals. When active, their metabolic rates are very high. The shrew is a nervous little creature that scurries around almost constantly in search of food and that does not exhibit clear periods of sleep. Under ideal laboratory conditions or in its natural habitat both phases of sleep are very likely present, but observation under seminatural laboratory conditions indicates that the shrew is an animal that can, and probably does, get by with little sleep. In contrast, bats sleep up to twenty hours per day, and during sleep their metabolic rate drops considerably. The life-span of the short-tailed shrew is about two years, whereas bats of the same size live up to eighteen years. Thus the bat's ability to "turn himself off" apparently results in a ninefold gain in life-span. In most animals metabolic rate during sleep does not decrease as dramatically as it does in the bat, but nevertheless it seems clear that the ability to sleep, and thereby conserve energy, can prolong life.

The daily temperature cycle (and therefore the underlying metabolism) is independent of sleep; therefore subjects deprived of sleep still have lower temperatures at those times that would correspond to normal sleep.

Specifically, we suspect that slow-wave sleep serves this function. It alone is present in the echidna, and it accounts for nearly all the sleep of birds, yet these animals maintain a constant body temperature as do marsupial and placental mammals. Paradoxical sleep in contrast is a time of heightened metabolic and nervous ystem activity. Slow-wave sleep may ave evolved parallel with temperaure regulation, as an active mechaism in the brain for periodically 'forcing" mammals and birds—with heir generally high body temperaures—to conserve energy. In amphibians and reptiles, whose body temperatures can drop to low levels, this active brain mechanism does not appear to be present.

For man, sleep is a recurring and persistent need. Attempts to stay awake for prolonged periods can have disastrous consequences, both psychological and physiological. Not every mammal, however, must bow to the demands of eight hours sleep per day. Certain of them, notably the hoofed animals, have evolved the ability to do without much sleep. In

ANIMAL	BEHAVIOR AND HABITAT	SLEEP
	"Good Sleepers"	
Mole	Carnivore, active day or night. Lives below ground in an extensive network of burrows.	Sleeps 8 hours per day in lab with almost no adaptation. 24% paradoxical sleep.
Ground squirrel	Herbivore, hibernates, prey. Lives in extensive burrows of its own making.	Deep sleeper, about 14 hours a day in lab. 25% paradoxical sleep.
Cat	Predator. Only the domestic cat has been studied.	Deep sleeper, readily sleeps about 14 hours a day in lab. 27% paradoxical sleep.
Macaque	Omnivore, strong fighter. Sleeps in tops of tall trees.	After short adaptation sleeps 8 hours a day, 15-20% paradoxical sleep.
Chimpanzee	Omnivore, most similar to man. Lives in tropical rain forests and shelters in tree nests at night.	After relatively short adaptation, sleeps 11 hours a day. 19% paradoxical sleep.
Man	Omnivore. Has mastered defense from other species and the elements. Chief predator is man. Inhabits all ecological ranges.	Deep sleeper. After short adaptation sleeps 8 hours in lab. 24% paradoxical sleep.
	"Poor Sleepers"	
Guinea pig	Herbivore; nervous, hyperactive, excitable; prey. Lives in burrows, which it excavates or borrows, in rocky areas, savannas, swamps, and at edges of forests.	After long adaptation will sleep 12 hours per day. 5% paradoxical sleep.
Rabbit	Herbivore, prey. Some strains are extremely nervous and easily excited. Usually lives in grass nests on the surface or occasionally in burrows.	Difficult to adapt; sleep is seen only after several months in lab with some strains. Up to 15% paradoxical sleep when well adapted.
Sheep	Herbivore; nervous, excitable; prey. Lives in grasslands. (Study includes only domestic species.)	Requires long adaptation. About 4% paradoxical sleep.
Goat	Herbivore, excitable, prey. Lives in grasslands or mountains. (Only domestic species studied.)	After two months adaptation will enter paradoxical sleep, but only rarely.
Donkey	Herbivore, excitable, prey. Lives in grasslands. (Only domestic species studied.)	After several months in lab will sleep about 4 hours a day, but paradoxical sleep apparently not seen.
Baboon	Omnivore. Strong fighter but subject to predation. Lives at edges of forests, in savannas and rocky areas. Sleeps in tops of scrub trees where it is easily visible.	Enters paradoxical sleep phase after extended adaptation. 4-9% paradoxical sleep.

Animals that have been studied in the laboratory can be divided into "good sleepers" and "poor sleepers." Good sleepers are either predatory or have secure sleeping places included in their way of life. Poor sleepers tend to be animals subject to predation at all hours; they sleep less and experience less paradoxical sleep.

these animals sleep is seen only under very carefully controlled laboratory conditions and then only after extended periods of adaptation.

There are several factors that determine how much a particular species needs to sleep, but perhaps the clearest is the predator-prey relationship. Predators such as men, cats, and dogs are good sleepers, whereas the animals most subject to predation at any time of the day, the hoofed mammals, are generally very light sleepers. Browsing animals—such as sheep, goats, and donkeys—were derived from wild species that were continually exposed to predators. These animals are poor sleepers and only rarely enter the paradoxical sleep phase. Only under the most carefully controlled conditions will they sleep in the laboratory. (This is also true of the rabbit, chinchilla, and guinea pig.) Folklore holds that domesticated ungulates do not sleep at all. When questioned, those familiar with various farmyard species usually cannot recall having seen one of them lying down with eyes closed, obviously asleep. It is probable, although lack of exact knowledge of their habits makes it impossible to say with any certainty, that most poor sleepers are surface-dwelling mammals that, because of their habitat or size, cannot retreat to well-protected dens or burrows to sleep.

Good sleepers, however, are not always predators. As examples, consider the 13-lined ground squirrel and the hamster, which live mainly on vegetation yet are good sleepers. These animals are not predatory but are themselves subject to predation. They are not surface-dwellers, however, and thus need not constantly monitor their surroundings. The ground squirrel or hamster snugly enclosed in its burrow can afford the luxury of deep sleep. Another example of a deep-sleeping nonpredator is the macaque monkey of Asia, a species studied in the laboratory. This primate is able to afford the luxury of deep sleep because his environmental surroundings allow it. He sleeps in treetops that have dense foliage at the crown. Nocturnal predators are rare. He is light in weight, nimble and small, and can climb to high places that his chief enemies cannot reach. The macaque is a relatively deep sleeper with high percentages of paradoxical sleep. In contrast, the African baboon, although a savage and bold fighter, is insecure while sleeping. At night, his chief enemy, the leopard—a skillful climber—is most active, and the baboon must seek the tops of the tallest trees available. Cover is poor in the scrubby trees of the savanna environment, and he is usually quite visible, silhouetted against the night sky. As a result, the baboon is a fitful sleeper and rarely enters the paradoxical sleep phase.

We believe, therefore, that the essential difference between good sleepers and poor sleepers depends on the security of the animal's sleeping arrangements and not solely upon his food-getting status. Examination of the list of animals studied in the laboratory indicates that secure sleepers tend to have large amounts of paradoxical sleep. Thus it appears that deep sleep and high percentages of paradoxical sleep go hand in hand with a safe sleeping arrangement. Returning to our comparison of shrews and bats, we propose that the bat can afford to sleep deeply because its security during sleep is assured, suspended as it is from the ceiling of a cave or attic. The shrew, primarily a surface-dweller, must be much more circumspect about the duration and depth of its sleep.

The importance of security for deep sleep has also been suggested by H. Hediger, a zoologist who has observed animals in their natural habitat. He notes that the antelope probably never sleeps whereas the Indian sloth bear, a fighter so competent that even the tiger avoids him, sleeps deeply.

What biological function is served by paradoxical sleep? Clearly evident in man, the most advanced mammal (while absent in the echidna, a primitive mammal), this form of sleep does not appear to be a vestigial remnant of our prehistory.

Apparently, paradoxical sleep is not simply a mechanism to provide dreaming. It occurs in situations in which the possibility of dreaming is remote. Cats that have had most of the brain removed, except for the vital respiratory and cardiac centers in the medulla, still have paradoxical sleep. Similarly, human beings with diseases that essentially disconnect the cerebral cortex and higher centers of the brain nevertheless have periods of paradoxical sleep. In both these situations it seems unlikely that dreaming could occur. Thus, it seems that dreaming does not necessarily occur during paradoxical sleep. It is interesting that these results also suggest that dreaming does not cause paradoxical sleep, but, if anything, is caused by it. Perhaps an increase in heart rate and rapid shallow breathing evoke emotional dreams, rather than the other way around.

One of the most striking and unexpected findings of sleep research is that newborn mammals, whether they are humans, cats, or rats, have much more paradoxical sleep than adults. The human newborn, for example, spends about 50 percent of his sleep in the paradoxical phase, while adults spend about 24 percent. (Premature infants spend an even larger percentage of their sleep in this state.) These studies suggest that at earlier stages of prenatal development, all sleep may be paradoxical.

These findings have prompted a plausible theory for the biological significance of this form of sleep. The rapidly developing fetal nervous system presumably needs a great deal of excitation to build in the neural circuitry necessary for the development of integrated behavior patterns. Because paradoxical sleep is a time of intense central nervous system activity, it may provide a period of nerve "exercise," the stimulation coming from within the brain instead of from the environment. In the course of maturation less internally generated brain stimulation is necessary because sensory stimulation is now available from the environment: the amount of paradoxical sleep, therefore, declines.

Other findings seem to lend support to this hypothesis. At birth, poor sleepers such as the guinea pig and lamb have less paradoxical sleep than more secure sleepers such as man and the cat. The former, however, are born at an advanced level of nervous system maturation. Shortly after birth they can walk, and their sensory systems are functional, unlike man and the cat who are born completely helpless. Presumably, since the sensory systems are well developed they need less internally generated stimulation and spend less time in paradoxical sleep. Similarly, the young of the hoofed mammals must quickly develop a responsiveness to their environment; the rapid maturation of the brains in such species and their small amounts of sleep are both adaptive responses to the same environmental pressures.

An intriguing theory of the biological role of paradoxical sleep was suggested by Frederic Snyder of the National Institute of Mental Health. His view is that this "third state of existence," as he calls it, serves to periodically arouse the sleeping animal so that he can inspect his environment for danger. In times of danger, animals (or men, for that matter) tend to sleep fitfully, in short bursts, and may awaken during a paradoxical sleep episode. This would explain why the insecure sleepers such as sheep, or guinea pigs get so little paradoxical sleep.

The advantage of such a "sentinel" mechanism is obvious: the animal is assured that his sleep will not be unduly prolonged; possibly forever in the case of the rabbit that does not see the approaching hawk. Furthermore, an animal aroused from paradoxical sleep is alert and reactive, ready for fight or flight, whereas awakened from slow-wave sleep he is disoriented for a few seconds. In addition, several kinds of evidence indicate that humans or cats can discriminate meaningful stimuli better during paradoxical sleep than during slow-wave sleep. Not only might paradoxical sleep serve to awaken the animal in danger, but he would awake ready to react in an integrated manner.

As far as can be determined with laboratory techniques, paradoxical sleep is similar in all mammals that exhibit it—from the opossum, a prototypal therian, to man, presumably the most advanced mammal. How similar, however, is the mental activity that might accompany the physiological signs of dreaming in animals and man? Is it possible, for example, for animals to experience visual imagery and other sensations during paradoxical sleep?

These are difficult questions to answer. We already know that paradoxical sleep can occur even when the possibility of any complex mental activity is highly unlikely. If we cannot automatically assume that dreaming occurs in humans during paradoxical sleep, we must certainly be cautious in making such an assumption about animals. Furthermore, to what extent can we ascribe human kinds of subjective experiences to an animal? Many scientists believe this is a futile, hazardous, even heretical undertaking. Darwin, on the contrary, insisted that mind, or consciousness, was a biological phenomenon that evolved from lower forms in much the same way as did anatomical characteristics. He pointed out that emotional expressions indicating particular "states of mind" were obvious in all animal forms. He went so far as to say, "even insects express anger, terror, jealousy, and love by their stridulations."

While it is difficult to attribute such complex emotions to so simple a beast as a cricket, it is reasonable to suppose that visual, auditory, and tactile imagery occurs in mammals. Most scientists have no particular qualms about attributing subjective states such as pain, hunger, and fear to animals. Yet an animal's outward manifestations of these states are not nearly so clear, not nearly so similar to the human manifestations of these states, as are the animal's signs of dreaming. We agree with the view stated many years ago by Julian Huxley:

"It is also both scientifically legitimate and operationally necessary to ascribe mind, in the sense of subjective awareness, to higher animals. This is obvious as regards the anthropoid apes: they not only possess very similar bodies and sense-organs to ours, but also manifest similar behavior, with a quite similar range of emotional expression, as anybody can see in the zoo; a range of curiosity, anger, alertness, affection, jealousy, fear, pain and pleasure. It is equally legitimate and necessary for other mammals, although the similarities are not so close. We just cannot really understand or properly interpret the behavior of elephants or dogs or cats or porpoises unless we do so to some extent in mental terms. This is not anthropomorphism: it is merely an extension of the principles of comparative study that have been so fruitful in comparative anatomy,

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If one is willing to admit that it is possible to infer dreaming in animals, then several lines of evidence indicate that it actually does occur. Recall that muscle tone in the cat is completely suppressed during paradoxical sleep. If the brain center that produces this suppression is not functioning, however, a bizarre pattern of events takes place during the cat's paradoxical sleep. Although completely asleep, the cat will display behavior almost identical to that during the waking state. It will rise, walk about, attack invisible enemies, stalk an imaginary prey, or sit quietly and follow an unseen object with its eyes for periods of several minutes—all while deeply asleep! It is difficult for an observer to deny that some sort of imagery is present in the cat brain at these times.

In another experiment that suggests dream life in animals, monkeys were trained to press a lever when they saw patterned stimuli flashed on a screen before them. Later, during sleep, they were seen to press the lever as if they were hallucinating or dreaming of the stimuli acquired during the waking state. Techniques such as this bypass the problem that animals cannot give us spoken reports of their dream life.

We are willing to conclude that imagery occurs during paradoxical sleep in animals. To the extent that they are capable of mental life during waking it is equally plausible to grant them the power of dreaming during sleep. And what do they dream about? Anyone who owns a dog has witnessed the trembling, jerking, abortive running movements, the grimacing and whimpering that periodically occur during sleep. A dream of a rabbit chase? Why not? Freud thought that dreams are often wish fulfillments. In *The Interpretation of Dreams* he wrote: "I do not myself know what animals dream of. But a proverb, to which my attention was drawn by one of my students, does claim to know. 'What,' asks the proverb, 'do geese dream of?' and it replies: 'Of maize!' The whole theory that dreams are wish fulfillments is contained in these two phrases." Perhaps cats dream of the perfect mouse, and moles of big juicy earthworms. We like to think so.

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The Zinacanteco Way of Life

by Herbert R. Harvey

ZINACANTAN: A MAYA COMMUNITY IN THE HIGHLANDS OF CHIAPAS, by Evon Z. Vogt. *The Belknap Press of Harvard University Press, $25.00; 733 pp., illus.*

Perhaps what we find most intriguing about the Maya are their ancient accomplishments and their modern staying power. The two are not wholly unrelated phenomena. While many Indian groups of Middle America have lost their distinctive cultural flavor, most of the Maya groups have not. The Zinacantecos, a surviving, indeed thriving, Tzotzil-speaking Maya group with which this book deals, are no exception. In fact, it is precisely the combination of a rich cultural content, which is peculiarly Maya in most details, and the mechanisms that have maintained it despite constant external pressures over the generations that accord more than the usual significance to this study.

Zinacantan is an almost wholly Indian municipio of nearly 8,000 people (1960 census) tucked away in the highlands of the state of Chiapas, Mexico, not far from San Cristóbal las Casas. The Pan-American Highway, which cuts through the municipio, was opened in 1950, thus linking the area for the first time with the modern nation. With the road came increased economic interaction with the lowlands, tourists, and a bevy of anthropologists, among them Professor Vogt and the many members of his team, who form the ongoing Harvard Chiapas Project. The present work is but one of many, which have already appeared or are in preparation, concerning this remarkable community of Maya Indians.

The author's stated purpose in writing the book is "to provide the first general ethnographic description of this Zinacanteco way of life. . . ." That is, in a nutshell, what the book is. However, it is perhaps better viewed as a "master ethnography" in terms of the strategy of the Harvard Chiapas Project. Over the the course of a decade, numerous students and colleagues of the author have participated in a coordinated field program in the area and

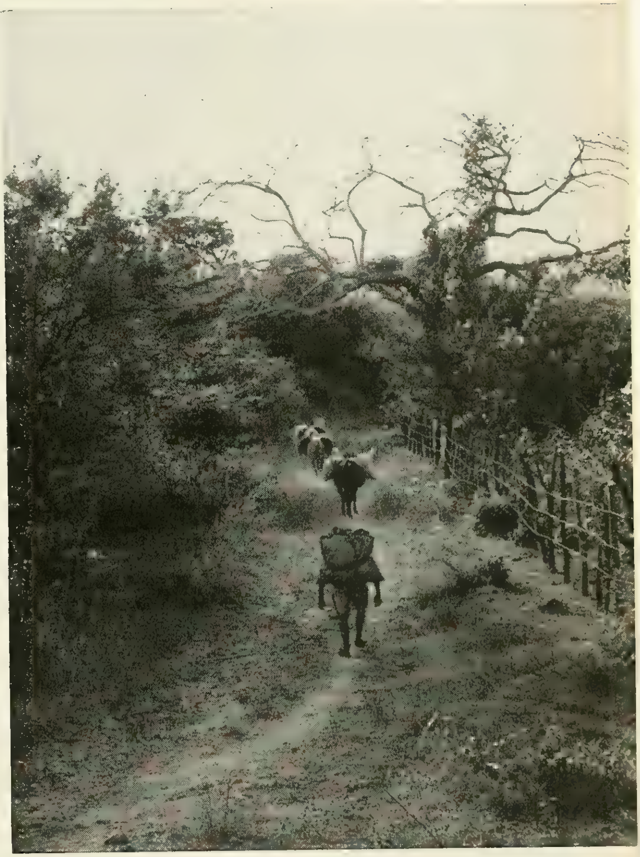
Zinacanteco shaman is packing white candles for a pilgrimage to the mountain shrines.

Shelling maize using cowhide net. Wooden cross in foreground protects corn from evil spirits.

have produced a large number of specialized studies. Throughout, the book draws upon these (with careful acknowledgement), as well as upon the author's own, extensive field work. Certain topics obviously have been more exhaustively studied than others, leading to some imbalance of coverage (an inevitable failing of general ethnographies). Also, a certain redundancy has resulted because the topics are discretely presented. The book emerges, therefore, as more of a topical compendium than a tightly integrated account of Zinacantan culture and society. This can be either a virtue or a vice, depending upon one's approach to the book. Suffice it to say, it is easy to read a chapter.

The population of Zinacantan is dis-

Men and animals bearing heavy loads of maize make their way along a trail.



tributed between a ceremonial center (called Zinacantan) and 15 dependent, outlying hamlets—a familiar settlement pattern for Maya. The Zinacantecos are maize farmers, and maize dominates not only their agricultural production and diet but also their thoughts. There is one exceptional aspect to their agriculture, however: in addition to their traditional farm plots in the highlands, they also have access to, and make extensive use of, lowland plots in the nearby Grijalva drainage area.

The characteristic domestic unit in Zinacantan is the patrilocal extended family, living either under one roof or in closely clustered houses forming a compound, symbolically represented as a cross. Several house cross groups make up a patrilineage, and one or more localized patrilineages constitute a *sna*, the next largest recognized social grouping. In turn, two or more *snas* combine to form a waterhole group, which in itself may equal a hamlet, although more frequently a hamlet consists of more than one waterhole group. In Zinacantan, the location and composition of settlements are determined primarily by the availability of water.

Religion is all-pervasive in the lives of modern Zinacantecos, and over half the book is concerned with it: the practitioners, the belief system, the sacred geography, the ceremonies and rituals, the cargo system (the religious hierarchy, or *cofradía*). The religious structure, essentially indigenous in content, complex and intricate in form, is portrayed with great clarity and detail. As such, the book is a major contribution to our growing knowledge of surviving native religious practices in contemporary Middle America.

What is surprising about this book is that it all but ignores population. A few basic facts are presented: the size of hamlets, the number of children enrolled in one school during two different years, and the municipio growth rate, plus a very few others. With virtually no demographic framework established, the question of number can gnaw at the imagination throughout the book. The author himself cites Frank Cancian's thesis that the cargo system, as it now functions, may not be able to withstand the rapid population expansion projected for the coming few years. In Zinacantan, as elsewhere, so-

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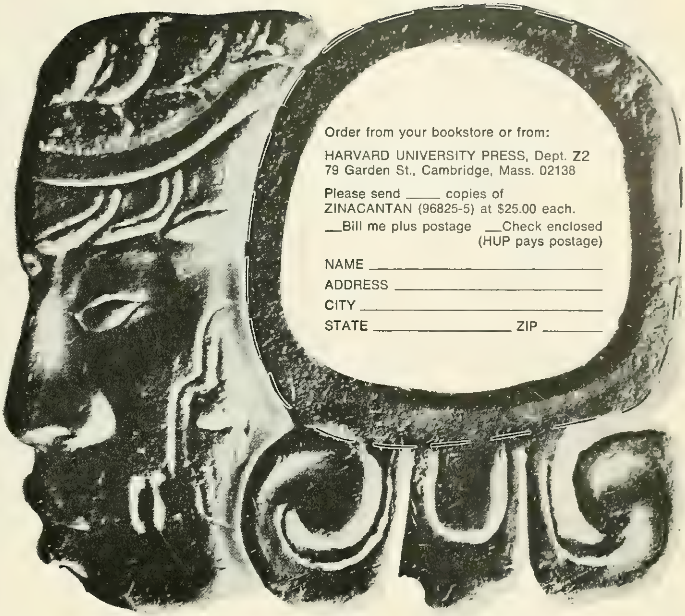
cial institutions are, or can be, closely related to the demographic structure. For many purposes, it would be more useful to know the present composition of Zinacantan's population, rather than the manner of house construction, which consumes eleven pages.

From the point of view of culture change, Zinacantan is one of the most interesting areas encountered in Mexico. In the first place, the question immediately arises as to how it survived four and a half centuries of Hispanic acculturative pressure, yet retained so much of its indigenous cultural integrity. While many traditional patterns are not "pure Maya" in the sense that they remain unaltered from pre-Hispanic times, the syncretism that occurred between Maya and Spanish elements left a heritage that is today "Indian," as opposed to Ladino or any other. One of the processes to which Dr. Vogt attributes this is what he calls encapsulation—"the conceptual and structural incorporation of new elements into existing patterns of social and ritual behavior . . . a special form of syncretism." As an example, "the trend of events has been for 'political' offices gradually to become 'religious' offices." Recently there has been an intensification in certain indigenous patterns. The number of shamans, for example, has increased considerably, and the ceremonies performed by cargoholders are becoming more elaborate and complex. Zinacantan, in other words, seems to be reacting to the current threat to its traditional culture by intensifying its activities in the religious sphere. A second question then arises as to what extent it has reacted in a similar fashion through the long centuries of the post-Conquest era, and by extrapolation, how representative is this group of the patterns of Maya culture that prevailed pre-Hispanically?

The question opens a whole other

Drum and flute players at Zinacantan ceremony.

province: historical reconstruction versus conjectural history, a poor substitute. The author doesn't seem to be quite sure whether he is using the present to explain the past or the past to understand the present. The two are not mirror images, at least in terms of methodology. What is interesting about this book is, not the conjectures about the ancient Maya (which may well be valid), but the description of the modern Maya and the historical *facts* that have had a direct bearing on the present and whose impact or probable impact can be reasonably inferred. The author is obviously more interested in searching the cultural pantry for "survivals"' than in determining historical cause and effect, but what is worse is that he treats the two as being of equal scale. Thus, "Tzotzil Prehistory and History" are both the subject of chapter 2. Also, in chapter



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—*Saturday Review*, August 23, 1969

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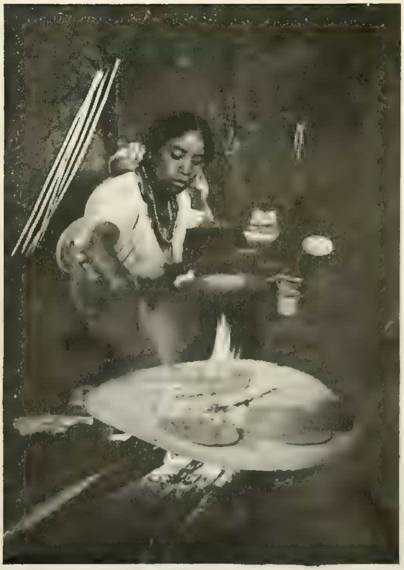

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Holding burning censer, a shaman prays over ritual paraphernalia.

25, "Implications for Cultural Change," such topics as the relationship between ancient Maya pyramids and modern lineage organization are treated along with the very recent impact of INI health programs on the community. This same chapter begins in 2600 B.C. with the suggested location of the proto-Maya speech community and ends in 1984 with some predictions about short-range "culture change": projected population total, paved roads, school enrollment, preferred house types, and others. By the author's curious kind of logic, the Zinacantecos are an "ethnic fossil" that has changed. This may sound more harsh than intended because the book is largely concerned with Zinacantan in the here and now.

Despite these general criticisms, the book's net impact is good. The author sometimes "thinks out loud," which adds a personal quality. The 200 illustrations are superb. Many full-page photos without borders take the reader right into Zinacantan, and not one seems superfluous. It is, in fact, one of the most skillful uses of photographic illustrations in the ethnographic literature and hopefully will start a long-needed precedent. Its eight useful maps are also tastefully done. The bibliography is extensive and the text is well documented.

For the future the author indicates that his work in Zinacantan will continue at least through 1984. I think that his contribution in this work will be appreciated far beyond then.

Dr. Harvey is associate professor in the Department of Anthropology of the University of Wisconsin at Madison.

ART OF ANCIENT EGYPT, by Kazimierz Michalowski. *Harry N. Abrams, Inc., $40.00; 600 pp., illus.*

The *Art of Ancient Egypt*, by Kazimierz Michalowski, has emerged from behind the Iron Curtain obviously to compete in the lucrative field of popular art books presently inundating the market, and like the Great Pyramid itself, it is the weightiest of its type (8 pounds, 4 ounces), covers the broadest base (three books in one), and is visually the most spectacular (145 color plates). However, unlike the Great Pyramid, which was sturdily oriented to all four cardinal points, this volume is given a totalitarian twist that distorts its direction.

The section in which Professor Michalowski, who is Director of the Polish Archaeological Institute in Cairo, writes on the civilization and art of ancient Egypt is the weakest part of the book. Ancient Egypt is presented as a state founded upon a rigid system of three social classes—the nobility, the administrators, and the masses—and all other facets of its civilization are dedicated to maintaining this social structure. Overseers with whips are trotted

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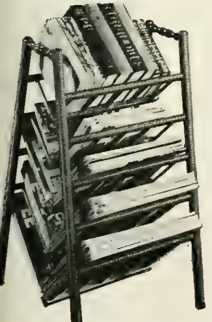

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out to beat the lower classes, but no mention is made of existing proof that men of most humble birth could, through sheer ability, rise to hold the most important posts in the land. Art, in its turn, becomes solely a propaganda tool, constructed by craftsmen according to canon to promote the power of the pharaohs. No mention is made that the ancient Egyptian was a deeply religious man whose art, created primarily for cult use, gave esthetic expression to his beliefs.

The picture book section is truly eye walloping. The color plates, although sometimes a bit dark and lacking in detail, give the over-all impression that all of Egyptian art was as sumptuous as the contents of King Tutankhamen's tomb. These plates, interspersed through the text, are followed by a section of some 600 small black-and-white photographs, which present a visual history of Egyptian art from the prehistoric through the Christian periods, with textual information limited to captions.

The section on archaeological sites is the strongest of the books within a book. It covers a geographic area from the Nile Delta to Nubia and describes 44 sites, each of which is identified by the details presently known about it—its hieroglyphic, ancient and modern names, its location within a general region, and in reference to nearby towns, its history and ancient importance. The history of its excavation since modern discovery is also given along with bibliographic references. Finally, the reader is told what remains to be seen today and is provided with maps, plans, and drawings. For the traveler who is serious about his sites, this is a good guide book but far too heavy to carry on the trip. It will be more useful as a ready reference for students and specialists.

The book is written in an informal, almost chatty style and moves along well, with vigor and with a minimum of errors by translator and editor. New ideas and theories about unsolved problems are presented as such at times, but at other times, they are presented as established facts. The reader is given a great quantity of material in this book, but, unfortunately, few options for its use, since each section falls short of its purpose.

Virginia Burton
Metropolitan Museum of Art

Animals and Maps, by Wilma George. *University of California Press, $9.50; 235 pp., illus.*

We are all aware that medieval maps were generally decorated with animals, plants, and landscape features, but we tend to think of these

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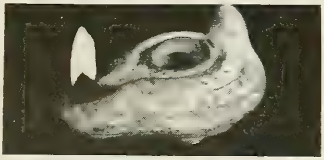

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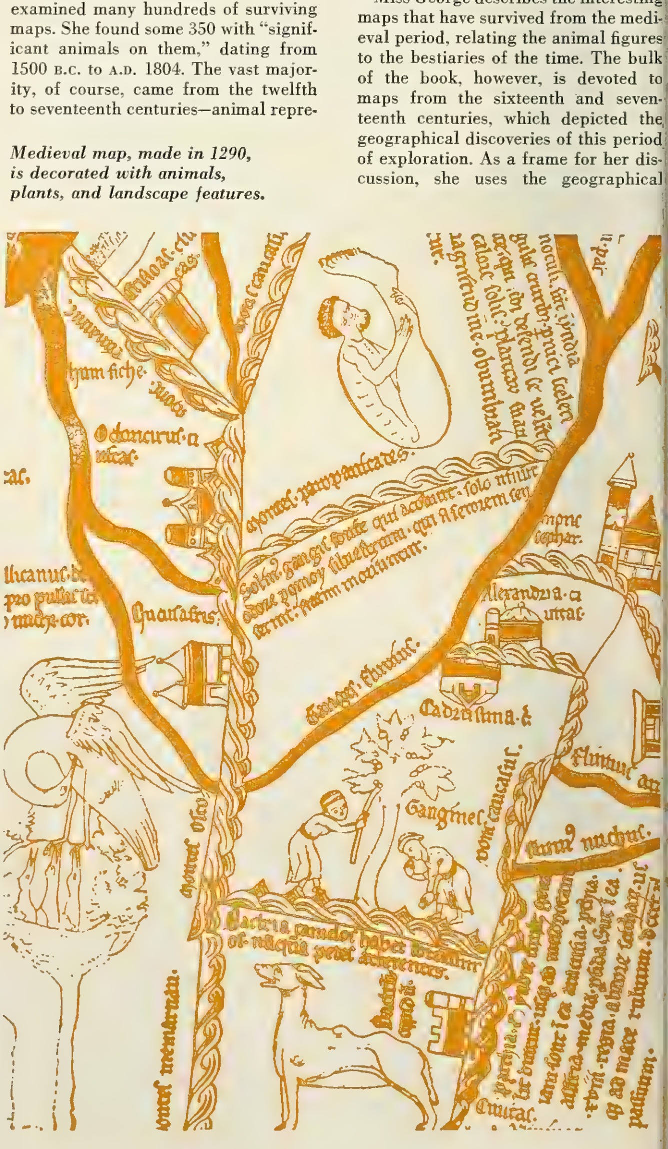
as purely ornamental because the animals were apt to be mythical or at least badly distorted. We assume that, lacking topographic detail, the cartographers filled in the blank spaces with the aid of their imaginations. This attitude is expressed in Swift's quatrain:

> So Geographers in Afric-Maps
> With Savage-Pictures fill their Gaps;
> And o'er unhabitable Downs
> Place Eelephants for want of Towns.

Wilma George began to wonder whether the mapmakers might not have had more serious intentions, and she examined many hundreds of surviving maps. She found some 350 with "significant animals on them," dating from 1500 B.C. to A.D. 1804. The vast majority, of course, came from the twelfth to seventeenth centuries—animal representation on maps becomes rare after 1700.

The oldest known map with animals was discovered recently in northern Italy. "It is a plan of a village engraved on a rock and dated at approximately 1500 B.C., in the European Bronze Age. On the outskirts of the village are depicted a deer, cow, dog and donkeys, mules or horses." Animal representations also occur on the clay-tablet maps of the Babylonians, and presumably they were used on the maps of classical Greece and Rome, although there is little direct evidence.

Miss George describes the interesting maps that have survived from the medieval period, relating the animal figures to the bestiaries of the time. The bulk of the book, however, is devoted to maps from the sixteenth and seventeenth centuries, which depicted the geographical discoveries of this period of exploration. As a frame for her discussion, she uses the geographical



Medieval map, made in 1290, is decorated with animals, plants, and landscape features.

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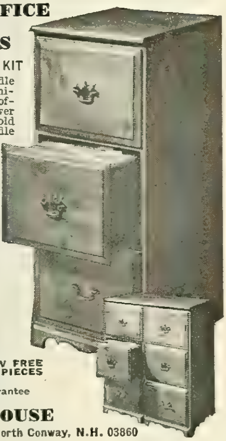
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regions described by A. R. Wallace, starting with the Neotropical and ending with the Australian. There is, of course, little material for the Australian region, since most of our knowledge of this continent came after the period when the use of animals on maps was fashionable.

Miss George was able to identify a large proportion of the animal figures used and finds that in general they correspond with contemporary knowledge. She thinks that the cartographers were trying to show animal distribution—not merely trying to fill up space—and she makes a good case. The book is generously illustrated with map reproductions, sometimes hard to make out because of the necessary reduction in size, but nevertheless fascinating. I think *Animals and Maps* could well be considered a major contribution to the early history of zoology.

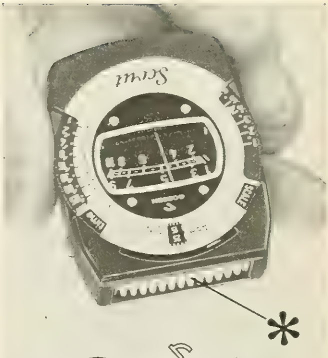
Marston Bates
University of Michigan

The Grand Colorado: The Story of a River and Its Canyons, by T. H. Watkins and contributors. *American West Publishing Co., $15.00; 310 pp., illus.*

Every essential fact and many essential comments about the Colorado River and the Grand Canyon are contained in the 300 pages of this absorbing book. It also contains more than 200 pictures, ranging from the pale, utilitarian photographs of John Wesley Powell's 1871 river run to the stunning present-day color photographs of Philip Hyde.

The text is by T. H. Watkins, editor of *American West Magazine*, and eight other specialists. It begins deep in history with the split-willow figurines made by Indians 3,500 years ago during the prehistoric Desert Culture era, and concludes with information about the national parks of today and the threatened intrusions on America's greatest natural fact. Although it is not intended as a book of entertainment it is completely engrossing. It should be the standard book for everyone who is seriously interested in the Colorado River and the Grand Canyon—"our greatest national wonder," in Wallace Stegner's vigorous prose, "our greatest scenic [which is to say spiritual] resource."

Everyone who has written about the Grand Canyon is aware of a fundamental obstacle: the Grand Canyon cannot be dealt with. It is not only too vast; it is incomprehensible. The physical scale is overwhelming. The records it has preserved of the history of the earth are not only fabulous but belittling. All the writers in this book are realistic men. But they, too, are aware of the numbing



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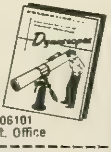

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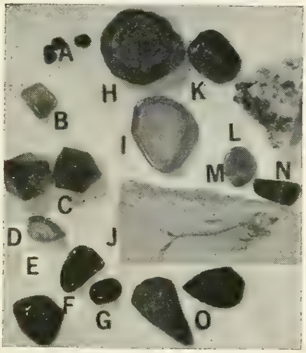

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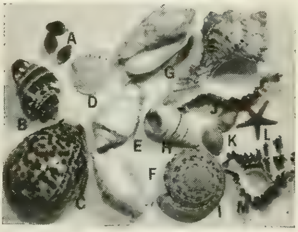

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fact that the Colorado River began to cut down to the bone structure of the earth millions of years before man climbed out of the slime, and it will continue to cut through the rocks and will crumble all the contemporary dams long after man has disappeared. In the Grand Canyon man faces the basic and pitiless truths of nature and civilization.

It is difficult to deal with *The Grand Colorado* adequately in a review because it contains bewildering records: the early irrigation adventures that baffled the river and made an agricultural industry out of a region designed for individual pioneers; the gigantic Imperial Valley adventure; the wonder of the construction of Hoover Dam; the tourist trade; the river running of today; the conservation crisis—too much happened, and man and the river have come into opposition in too many places to make the record simple. *The Grand Colorado* is like the Grand Canyon in one respect; it cannot be assimilated casually.

Although the book is not propaganda it contains many facts pertinent to the conservation point of view. The Colorado River is overcommitted; too many people expect too much of it. In 1893 Powell told promoters that there was not enough water in the Colorado to irrigate all the land that could be irrigated. It runs through a region that has only ten inches of rain a year—only one-eighth of which survives evaporation and transpiration through the leaves of plants and trees. In the century since Powell removed the last pocket of mystery, the Colorado has been exploited and damaged. The project for one more dam at Marble Canyon has not been dropped; it has only been postponed. Some day the Bureau of Reclamation, which is in the construction business, and promoters and politicians will make further assaults upon a sorely overworked river.

In protecting the environment, conservationists are always at a disadvantage. Industrialists, businessmen, politicians and bureaucrats have more influence in Washington than private citizens. To begin with, the citizens have no backlog of money. The exploiters have not only money but organizations of paid advocates who can lobby among friends. This book reminds us of what happened to the valiant David Brower, then of the Sierra Club, when he defended the Grand Canyon against exploitation in 1966. To alert the nation to the proposed dams and other intrusions on the national environment, Mr. Brower published a challenging advertisement in *The New York Times* and the *Washington Post.* Within six months the Internal Revenue Service—acting within the law— removed the tax-exempt status of tl Sierra Club. One arm of the goverı ment (Internal Revenue Service) spee ily came to the support of another ar of the government (Bureau of Recl mation). Although conservationists a numerous, they are relatively powe less. The disposition of the governme is to please exploiters of natural r sources who have political power.

The Grand Colorado, although it a modest book, tells a story that wi always be pertinent to the physical an spiritual health of America. It do not let the squalor of business an politics smother its sense of wond about life.

P.S. to the editor and publisher: I God's name, give us some practic maps. The book contains several hi torical and decorative maps and on technological map. But it contains n clear, modern map that performs th prosy function of locating the plac mentioned in the text.

BROOKS ATKINSO
Author and Crit

LIFE AND DEATH OF THE SALT MARS
by John and Mildred Teal. *Atlanti Little, Brown and Co., $7.95; 278 pp illus.*

John and Mildred Teals' *Life an Death of the Salt Marsh* is one those books that makes its greatest e fect, not by reason of emotion, bı through objectivity. Written with gre clear-headedness, this is the detaile story of an environment that is disa pearing at the hands of man.

Basically, a marsh is fertilized an cultivated by means of the tides. Ma may be able to raise shrimps, clam or oysters in pools in salt marsh area but once destroyed, he cannot brin back a system that is so dynamicall and intricately balanced, so depende on ages of development. Marshes ar a prime example of an environme that man cannot duplicate. The brut treatment they are receiving point up our glaring inability to bridge th gap between our actions and their r sults. With respect to most natur environments, we cannot wholly repai the losses we cause; we cannot mak substitutions that are ultimately us ful.

Because of its difficult, constantl changing environment, a salt mars is fairly limited in its plant and anim life. Yet it is a beautifully balance entity, a living thing that can rebuil itself. For the very reason that a mars is a hostile place, it requires som highly complex adaptations. This boo has a fascinating chapter, "The Dom nant Spartinas," about the two vari ties of grass that prevail in the marsh of the east coast: "Spartina survive

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in the hostile atmosphere of the salt marsh and endures the sea by keeping most of the salt out of its sap, and by concentrating some of this same salt in its cells so that they will be able to resist the tension placed upon the sap by evaporation occurring through the stomata. It is a success story of the most complicated nature."

That is a basic bit of scientific news. The way in which spartina overcomes its hazards suggests all kinds of fragility, tensility, areas of balance, all kinds of hardihood in nature. Attendant on the marsh grass, as this fine book points out, are many other adaptations among crabs, marsh snails, lugworms, insects, ribbed mussels, and killifish; and the influence of the marsh is great in the sea waters beyond it. Salt marsh grass, on which the existence of the marsh depends, is a triumph, a dynamic success, like all the other lives in this environment. What better can *we* do?

Anyone who drives down the east coast will come across signs of what man has done to the marshes. There is not much evidence of compromise. When we pollute, dredge, fill, and so on, we do it with an obliterative will. And the more money talks louder than the values of life itself, the more mired we are going to be in our own wastelands.

This fine book establishes a carefully documented case. There is some evidence that politics may be starting to take such cases seriously. In the meantime, if reason, plus an admiration for the working of things, can help save the marshes, this book will play an important role. One thing seems obvious after reading it: the problems of man's survival and those of his environment are inseparable.

JOHN HAY
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Sky Reporter *(Continued from page 28)*

innermost corona (the sun's outer atmosphere) will begin to show as a thin ring of light surrounding the moon. Sometimes a long-lived bead of sunlight will remain for a few seconds, glistening like a diamond within the ring of the corona.

Totality: As totality begins the entire corona will flash out and the brighter stars and planets will explode into view. Now the whole landscape is plunged into darkness, sometimes so great that one cannot see his hand in front of his face; usually however, one can read a newspaper by the dim illumination. Generally, the moon appears jet black—hence the name "bull's eye moon"—but sometimes it may appear slate colored with tinges of red and violet. An observer cannot see any detail on the moon's disk—as he can when the "old moon is in the new moon's arms." The moon will hang like a ball suspended in space, giving a strong three-dimensional effect.

For a few seconds at the beginning and end of totality, the chromosphere, or sun's innermost atmosphere, may be visible. A very thin arc of light, it has the color and brilliance of a ruby, contrasting sharply with the black moon and pearly corona.

Rising upward from the chromosphere at irregular intervals, sometimes to great heights above the solar surface, are the prominences, great flamelike jets of hydrogen gas. Pink, scarlet, reddish violet, or magneta, they contain a wealth of detail. They are most numerous at sunspot maximum, a period we have just passed.

Surrounding all this and extending several luna diameters on either side of the moon is the outermos solar atmosphere, the corona. Pearly white in appea ance, its over-all brightness is about that of the fu moon, but it is some 10,000 times brighter at its bas than where it fades into invisibility away from the sur At the March eclipse great coronal streamers, overlap ping one another and extending outward about the sam distance in all directions, should be visible. The coron is set in a deep blackish-blue sky that somewhat re sembles the night sky during late twilight.

At mid-totality, the sky overhead will retain the dar navy blue color, but as one looks down toward the hor zon in all directions the sky will become yellower an redder, as well as brighter. This happens because far o on the horizon the sun is still shining—but only as a thi crescent. The only sunlight entering the shadow does s indirectly, and the blue end of the spectrum is filtere out so that only the red remains. The farther the outsid edge of the shadow, the redder will be the horizon. I March this distance will be at least 40 miles along th center line of totality, closer to the northwest or south east near the edge.

As the darkness descends, birds will go to roost, flow ers will close, and animals will bed down.

Within about three minutes totality will end and a of the phenomena will occur in reverse sequence, th lunar shadow moving rapidly off to the northeast.

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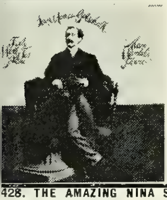

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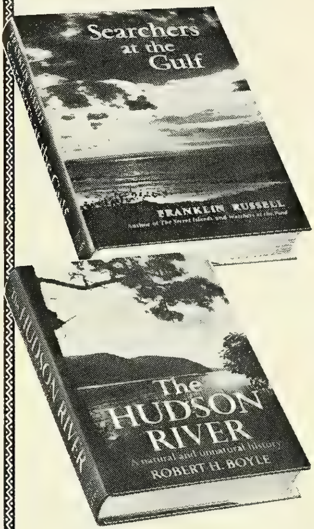

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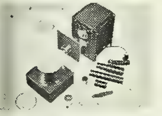

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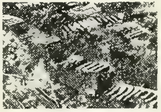

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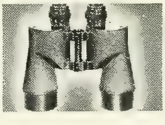

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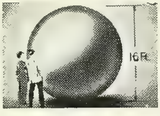

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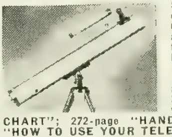

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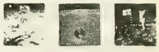

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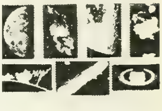

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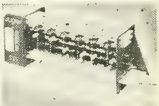

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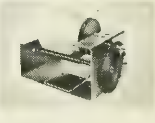

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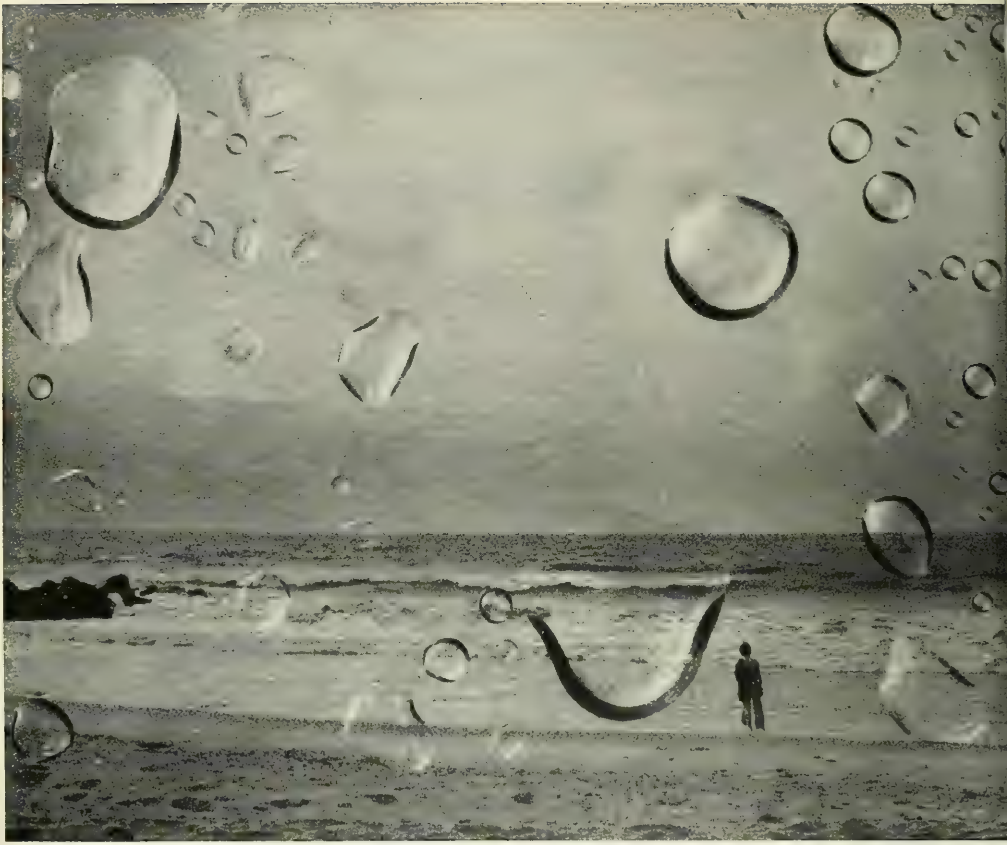

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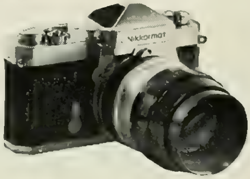

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NATURAL HISTORY

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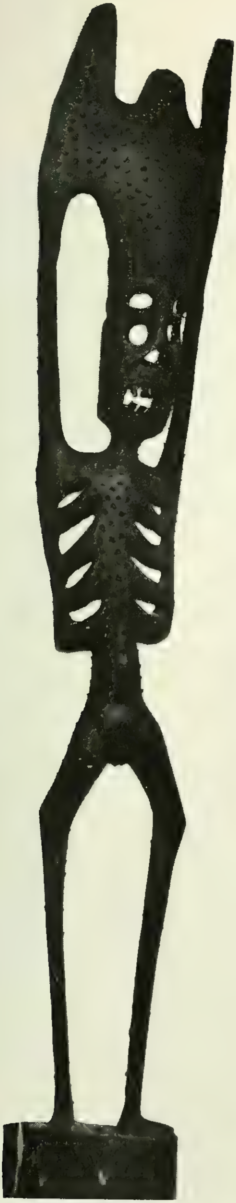

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Publication Office: The American Museum of Natural History, Central Park West at 79th Street, New York, N.Y. 10024. Published monthly, October through May; bimonthly June to September, Subscription: $7.00 a year. In Canada and all other countries: $7.50 a year. Single copies $1.00. Second-class postage paid at New York, N.Y., and at additional offices. Copyright © 1970 by The American Museum of Natural History. No part of this periodical may be reproduced without the written consent of NATURAL HISTORY. *Manuscripts and illustrations submitted to the editorial office will be handled with care, but we cannot assume responsibility for their safety. Opinions expressed by authors are their own and do not necessarily reflect the policy of The American Museum.* NATURAL HISTORY *incorporating* Nature Magazine *is indexed in* Reader's Guide to Periodical Literature.

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THE AUTHORS

"Green Mountains, Green Money," a discussion of the problems and pressures of land development in Vermont, concludes **Richard M. Klein**'s two-part article, "Bananas in Vermont." Dr. Klein is professor of botany at the University of Vermont and, with his wife, also a plant biologist, the author of *Discovering Plants*. Dr. Klein emphasizes that he is writing as an individual, not as a representative of the university or of the state of Vermont.

Stephen W. Hitchcock, our "Naturalist at Large" this month, is an entomologist working for the state of Connecticut. He received his M.A. and Ph.D. in entomology from the University of California at Berkeley, and is currently involved in a study of aquatic insects. The author of several popular articles, including one on the gypsy moth for *Audubon*, Dr. Hitchcock has also published more than thirty research papers in biological journals. His field work has included the taxonomy of stoneflies, side effects of pesticides, biology and behavior of aquatic insects, and biology and life history of caterpillars.

Nina Leen is a staff photographer for *Life* whose work includes more than fifty covers for the magazine. Her photographs of bats in this issue of NATURAL HISTORY are taken from her latest book, *The World of Bats*, with text by Alvin Novick, to be published this spring by Holt, Rinehart and Winston. Although her photographic topics are diverse—including art, people, and history—she has recently been concentrating
subjects relating to the natural wo
and science. Among her many d
tinctions, Mrs. Leen is the o
woman who has won three pri
awards for color essays in the P
tures of the Year Competition; a
the only person to photograph th
reigning monarchs of all the roy
houses of Europe and the heads
royal families in exile.

Alvin Novick is a physiologi
who has specialized in experiment
work with bats. Associate profess
of biology at Yale University, D
Novick heads a bat laboratory the
and has done extensive work i
Africa, Ceylon, and in various Ne
tropical countries.

A native of the Netherlands, **Me
chelina Shore-Bos** is a free-lan
researcher, artist, translator, and a
historian. She has spent the last fou

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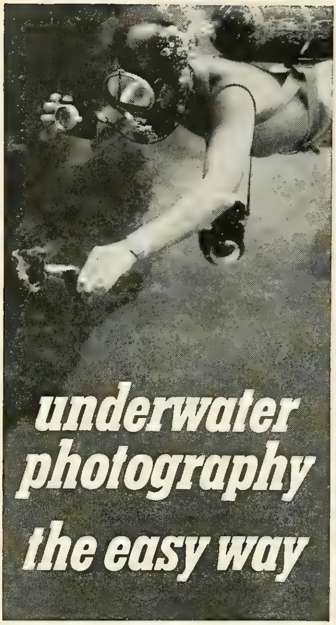

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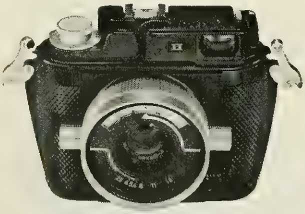

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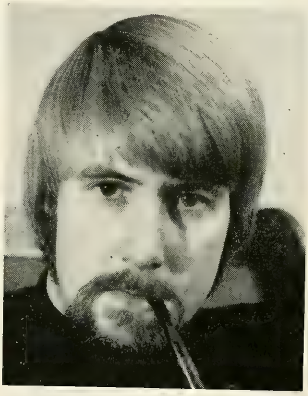
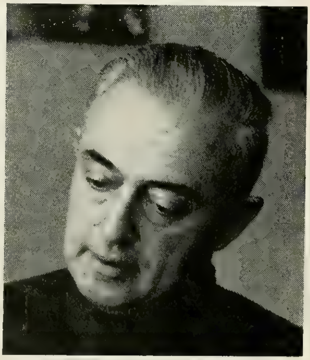
years in Tanzania, Kenya, Uganda, and Ethiopia doing field work on East African art, particularly the sculpture of the Makonde. The author of the forthcoming book *The Art of the Makonde*, Mrs. Shore-Bos plans to continue her studies in traditional and modern East African art.

A free-lance photojournalist based in New York City, **Richard H. Hofstrand** grew up in the woodlands of Minnesota where he first became interested in the wild rice culture of the area. Primarily interested in the documentary picture story as a method of communications, Mr. Hofstrand has completed a picture essay on wild rice, which will be published in a book by Time-Life this summer.

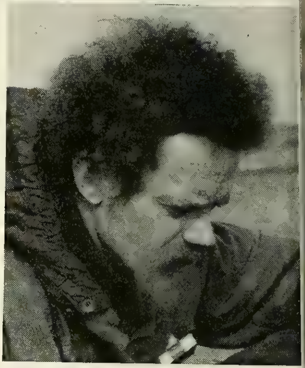


A researcher at Harvard's Peabody Museum of Archaeology and Ethnology, **Alexander Marshack** has spent the last six years using new microscopic techniques to reexamine prehistoric Ice Age and post-Ice Age art treasures of Europe.



In his book, *The Roots of Civiliz tion*, to be published this fall McGraw-Hill, he will offer a reinte pretation of man's first art, symb and notation. This research was co ducted with funds from the Nation Science Foundation and the Wenne Gren Foundation.

"The Gulls of Walney Island" primarily the result of **Micha H. MacRoberts**'s postdoctoral r search with Niko Tinbergen's Animal Behaviour Research Group in Oxford. **Barbara R. MacRoberts**, also a research officer with this group, is particularly interested in sociality and selection pressures in primate behavior and in behavioral adaptation. She plans to do further research on Walney gulls relating to territorial behavior and population growth. Anthropologists by training, the MacRoberts have done field work on the social organization of Barbary apes in Gibraltar and research on Walney gulls in Lancashire.



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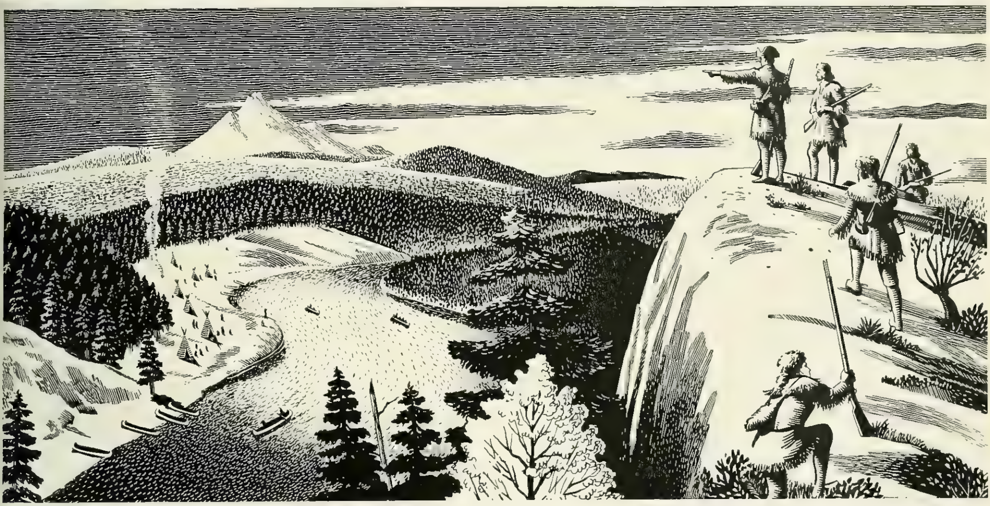

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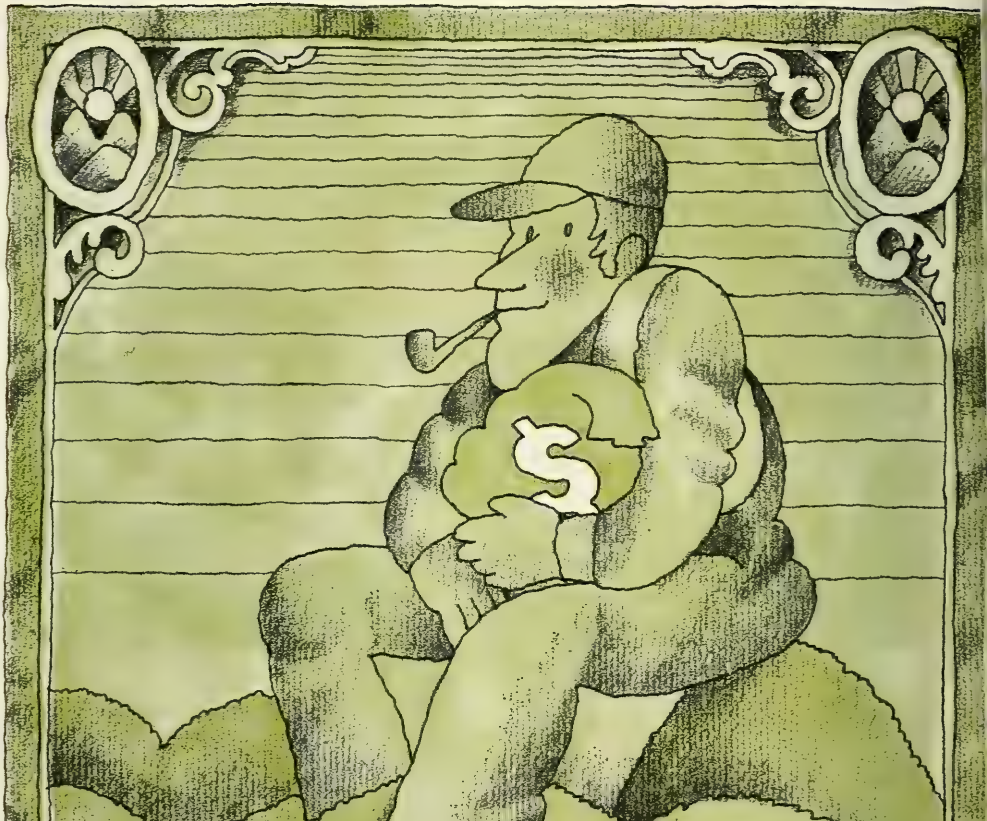

Ruffins

Bananas in Vermont, Part II

Green Mountains, Green Money

Vermonters still have time—but not much—to save the beauty of their environment from bulldozers

by Richard M. Klein

The state of Vermont and its people have a very favorable image throughout the United States. Visions of frosty mornings and horses pulling sledges of maple sap to a steamy sugar house, the Long Trail in the summer and ski trails in the winter, hillsides ablaze with autumnal colors, and residents with a reputation for honest taciturnity, frugality, and homespun hospitality make people beam when you say you are from Vermont. Surprisingly, all this is true: Vermont is a *Reader's Digest* ideal. Yet the state is caught in the grip of another part of the American ideal, the concept of rising material expectations, and is wrestling with the question of how to pay for it.

One solution attempted over the past few years has been to attract new industry whose activities will not destroy the land, the water, or the people. This has been reasonably successful; today, industry brings in more money than farming, and there are now more people in the state than cows—a reversal of the situation that prevailed not too long ago. To continue to attract clean, nonpolluting industry, electric power is required, and the current furor over the construction of atomic energy generating plants in Vermont is an ecological example of the academic "on the one hand, but then again, on the other. . . ." It is likely that there will be a second atomic energy plant built in the near future, but it is still an open question whether it will be rammed down our throats by Vermont Yankee Power and the Atomic Energy Commission or be designed so as to truly limit inherent environmental insults and provide additional benefits to the land and the people.

Utilization of land in Vermont presents about as many problems as does power. A short growing season, shallow soil, traditional rockiness of the fields, and abrupt transitions in elevation all dictate that much of the state is agriculturally marginal. Large tracts in and near the Green Mountains were held in timber, culled to sugar maple, or left alone with occasional selective cutting of timber. Up to about the end of World War II, land simply wasn't worth much; it went for less than $20 per acre. Land deeds are so written that acreage is casually given as so many acres "more or less" and a 10 percent variation, usually greater than smaller, is expected. Because of depressed valuation, land assessments and land taxes brought in relatively little money. Even today, Vermont's Department of Forests and Parks owns over 100,000 acres in the state and in 1968 paid town taxes of about $.31 per acre. In one town, Groton, the state's holdings constitute more than 20 percent of the tax listings. These are fine recreational lands; if they were taxed according to their fair market value, Groton would be wealthy—and the town knows it.

Four lumber companies—St. Regis, Brown, Atlas Plywood, and International Paper—own close to 800,000 acres of land in Vermont. Under sustained-yield forest management, profit on an acre of timberland is about $1.50 per year. When land is assessed at its fair market value, the taxes on such land can easily be higher than the timber income. Landowners and towns realized that there is both immediate and long-term money in developing the land for recreation. With this realization, some towns are raising land taxes to force owners to sell for development, and many towns are under pressure to sell off their municipal forests for both immediate cash and long-term tax gains. The land boom is definitely on.

Land development and land speculation are old hat in the United States, and Vermont is no exception. The state's founding fathers, Ethan and Ira Allen, pushed their Onion River Land Company between bouts with the British. The first governor of Vermont, Thomas Chittenden, speculated in real estate while in office. Small-scale developers came and went for a hundred years or so—their avarice or their honesty had small effect on the over-all stability of the environment.

Today's activities are, however, on a scale several orders of magnitude greater than anything ever seen before. The affluence of at least part of the population, the decreased livability of the eastern seaboard's megalopolis, the extension of superhighways and the cars that use them, and the desire of many people to breathe fresh air at least part of the year—all these factors mesh neatly with the situation in Vermont where agricultural and forested lands are economically unprofitable, and where the towns and the state are desperately searching for a firmer, broader tax base to meet the spiraling desire for government services. It is no longer a question of whether Vermont land will serve as the environmental safety valve for city people and as the economic salvation of the towns, but rather of who will provide the developmental services and how will such development be controlled.

Vermont is divided into fourteen counties. Windham County, my focus of attention, includes the southeastern part of the state with the Connecticut River forming its eastern margin. Brattleboro, population

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13,000, is the only community of any size, with small towns, villages, and hamlets dotting the rest of the county. The county is very lovely. It boasts eight ski areas, including the renowned Mount Snow-Carinthia-Haystack complex and Stratton Mountain. Thousands of well-heeled visitors (a pair of skis can cost $200; boots, $150) receive their first taste of Vermont through skiing visits. Green Mountain National Forest, several reservoirs, excellent trout streams, and a series of tranquilizing vistas have stimulated the desire of many people to own a piece of Windham County.

Local officials thought that they were knowledgeable about summer people. In 1968 there were 3,246 vacation homes (called "camps" by real Vermonters) in the county; Vermonters owned less than 20 percent of these. People from Connecticut, Massachusetts, and New York owned the rest. About $600,000 was realized from property taxes; the average tax bill per camp was less than $200, and none of the towns got rich on that. Of course, purchases and services brought in additional money. At the end of 1968, there was greater appreciation of summer residents since they accounted for one-quarter of all revenue. As of the fall of 1969, the situation was very different; it can best be evaluated by focusing on two townships in Windham County, Dover and Stratton. The situation in these towns is atypical only because things have moved faster here than elsewhere in the state.

The town of Dover is just a few miles from the Mount Snow-Carinthia-Haystack Mountain ski complex. There are 23,000 acres in Dover Township with 2,000 acres tied up as national forest. Four hundred people are registered voters. Up to about 1955, Dover's economy was agricultural with considerable lumbering, but today only one farm is operative and lumbering is minimal. In keeping with its location, its facilities, and its economic position, the annual town expenditures and the decisions involved in disbursing its funds were not onerous for the town clerk and three unpaid selectmen. The spectacular success of the ski areas resulted in additional revenue; ski patrons and ski bums were in, but not of, the town during the winter and generally disappeared with the snow. There were 300 summer residents as 1968, and the possibility of an i creased number of camp owners i colonies surrounding the ski are was viewed with interest. The Mour Snow Development Corporatio owned and planned to develop severa moderately sized areas, and other sk companies were also considering thi prospect to provide year-round us of their facilities.

With these possibilities in mind the town had published a zoning ordinance in January, 1967, to ensur the orderly development of summe homes. The minimum requirement for lot and house size, setback fron roads, access, and so on were in keeping with tradition and commor sense, but they were just that—minimal. Except for the general statemen that there should be no hazards to health and that the creation of unsanitary conditions was to be prevented, health and safety regulations were essentially lacking. Basically, Dover does not have the manpower or the expertise to regulate home development, and the town finessed with the hope that state standards and controls would fill in the gaps.

Including the ski areas, there are now over twenty developers in Dover holding close to 7,000 acres. In 1966, West Virginia Pulp and Paper Company sold 3,400 acres of timberland to the Pineland Realty Company, and this parcel was subsequently sold to the Vermont Lumber Company. Eugene Coleman, an active land buyer, acquired Vermont Lumber shortly thereafter and initiated the development of Dover Hills. He sold out quickly to the Cavanagh Leasing Company of New York and Florida. Cavanagh Leasing and Caveland Equities are both directed by Mr. Coleman; stock, which sold for $9 a share when first issued at the end of 1966, was worth $70 per share in August, 1969.

Vermont Lumber essentially went out of the lumber business in 1968 when they announced that they were going to develop 550 acres of their total acreage. If we eliminate land already in homes and discount roads and land that is too steep or otherwise unsuitable, Vermont Lumber owns one-sixth of the land area and controls about one-half of the future of Dover. Decisions affecting the future of the town are out of the hands of the people themselves.

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In the spring of 1969 an attempt by the townspeople to restrict building height, control road frontage, and regulate building permits was countered when urban developers swamped the town meeting with company lawyers, a company planning consultant, and $600 in slick publications. The tidal wave of talk by this outside talent effectively packed the meeting, and the local residents—who are the only voters—didn't have a chance. One townsman, Jack Veller, has said that those who will determine the nature of the environment have no sense of Vermont history, no love of land, and no permanent interest because they will never live in Dover.

Of Vermont Lumber's six planned developments, Dover Hills and Dover Hills West are the biggest and are being pushed the hardest. Although lots of one to twelve acres are for sale, the average lot size is just over one acre and the average price is between $5,000 and $6,000. Even at these prices which, incidentally, have greatly inflated the base for tax assessments at "fair market value," about three-quarters of the lots were sold by August, 1969. Assuming that just Vermont Lumber sells all of its acreage, a town of 400 voters will include 3,000 additional homes. Camp owners cannot vote, but their impact on the town and their just demands for road clearing in winter, police and fire protection, and administrative services cannot fail to create severe strains in this community.

Dover Hills is being marketed by the hard sell. My letter from their marketing director, Paul Thibert, was accompanied by a slick brochure with pictures of beautiful people lounging before roaring fireplaces, golfers, pretty girls on horseback, trout streams, and uncrowded ski-lift lines (probably taken on a Monday morning). Dover Hills is "close to convenient shopping, schools, houses of worship, theaters, medical facilities." It depends on what you mean by convenient; furthermore, the public schools of Dover just meet the state standards for room volume per pupil, and hospitals are 25 miles away in Bennington or Brattleboro. Vermont Lumber is using telephone contacts straight from the Connecticut telephone directories; they have not had to extend their area of sales pitch. If a prospect is at all interested, the company sends a "sit-salesman" to the prospect's home to sit down with the family, present a slide show, and discuss the matter. If still interested, the client (no longer a prospect) is invited up for an all-expense weekend where considerable pressure is employed to get a 10 percent refundable down payment. Questions about who wears what pants in which family, appeals to sympathy for the salesman's children, discussions of the value of land as a hedge against inflation, and downright rudeness limit the percentage of returned down payments.

The company has gone to some expense to give the client a good show for his weekend visit. New roads run pleasantly through the development. They have cleared the brush and groomed the woods for about one hundred feet back from the roads, most effective for giving the impression of a mature forest. Sales pitches are replete with promises of things to come, including a 70-acre lake, a golf course, stables, a village shopping center, and (affluent society, indeed!) an airport. As of this writing, none of these extras has materialized. Their promotion speaks of "exclusive Ellis Park," but this is a one-acre site with a picnic table and a children's section containing slides and swings like those in many backyards. Because of a weird loophole in Vermont law, salesmen don't have to be licensed by the state, or even be residents, and their promises beyond the contract are as reliable as snow in June. In an effort to allay the town's concern over schools, one of Vermont Lumber's officials indicated that they would consider donating land, but would assume no responsibility beyond this. Fortunately, there has been little cutting in Dover Hills, and a restrictive covenant under consideration may prohibit extensive tree removal, as well as set broad limits of house size, color, and area. One model home, priced at about $23,000, is completed. It is carpeted, but its imitation wood paneling is apparently nailed to bare studs, for the walls give with gentle finger pressure. Few of the owners have erected homes, but those that have been built are unimaginative, out of keeping with the land, or downright ugly. They are mostly precut or modular units ranging in price from approximately $12,000 up to about $45,000 for the more ornate A frames.

The major entrance road into both Dover Hills and Dover Hills West comes off the main road in the village of Dover Hills West. It has a fairly steep grade and it might be exciting to see some 8,000 people trying to get in or out on a snowy weekend; snowbound vehicles have already overtaxed road maintenance crews. The local fire department is composed of volunteers whose equipment is adequate for present needs, but the new homes and open woods present a fire hazard (no hydrants, for example) that is likely to be reflected in insurance rates. Vermont Lumber has apparently given no thought to rubbish disposal, even though new state laws drastically limit expansion of town dumps.

Although population pressures, taxes, aesthetics, and other problems exist in Dover Hills, the basic worries are water and sewerage. Vermont gets 35 to 40 inches of rain per year, and a good share of this percolates into the ground. With Dover Hills' 550 houses, about 3,000 square feet of land per housing unit will be covered by houses and roads, effectively sealing off about 1,650,000 square feet of land surface. Thus, over 3,000 gallons of water per housing unit for each inch of rain will have to be carried off instead of entering the ground water supply: erosion, silting, and minor flooding can result. Dover Hills will not have a consolidated water supply; each house must have its own well. This may be fine for the man at the bottom of the hill, but the man on the top may find that his well will run dry. The valley householder may not be too well off either, because runoff from the top can flood his property.

In a report to the governor's Commission on Environmental Control, my colleagues Hub Vogelmann, Jim Marvin, and Max McCormack discussed the ecology of upper-elevation land in Vermont, defined as areas above 2,500 feet. They noted that these lands are the primary sources of abundant, clean water in the state because forested land holds rain and collects fog moisture. The soils are generally shallow and rocky, and road construction—or even extensive foot traffic—severely alters infiltration and percolation of water. It is enough to note that a fair propor-

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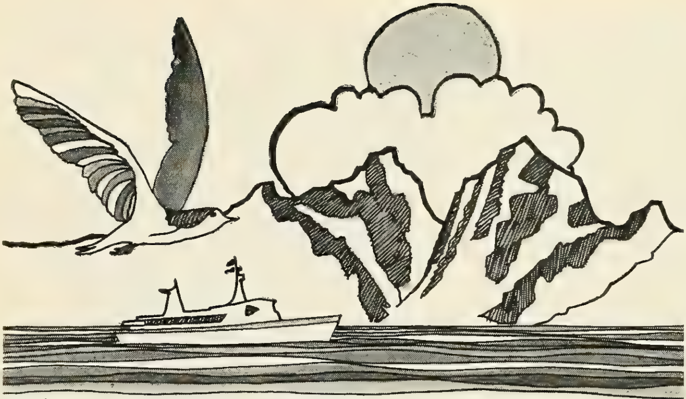
tion of Dover Hills is located at about 2,500 feet; indeed, lots with breathtaking views, which command the highest prices, are at 3,000 feet.

Dover Hills will not have a consolidated sewage system; each house will have its own septic tank. Assuming that each person in each house uses 50 gallons of water per day and that there will be five people in a house, the septic tank must handle 250 gallons of effluent daily. You can multiply this by 550 (the number of homes) to get an idea of the volume of waste to be disposed of.

Bruce Watson, the state soils man, has surveyed in the Dover area. The mountain soils are thin, allowing relatively little soil volume and drainage for a leach field. Raw or partly digested sewage from such a field, plus seepage from the septic tanks, may eventually get into the groundwater and contaminate the wells, particularly those on the lower slopes. Septic tanks used sporadically in vacation homes function more poorly and break down sooner than those servicing year-round homes because they become less efficient. Since bacterial action is depressed by cold weather in areas where soils are shallow, overflow of undigested sewage can be expected. A "sniff test" in several developments indicates that health hazards are already accompanied by aesthetic insults. A Public Health Service team has reported that about one-third of all water systems examined in Vermont were contaminated with sewage. Indeed, well pollution in southern Vermont developments has already been reported by distraught vacation homeowners. Undigested effluents can kill trees, compounding the damage.

Before detailing the reactions of the state to such a development as Dover Hills, a look a few miles up the road might be interesting. In neighboring Stratton township there is a major ski resort that may soon have clusters of vacation homes around the slopes. In 1968 Stratton had only 94 vacation homes paying a bit over $6,000 in taxes. The township has well over 23,000 acres of timbered land ripe for conversion into vacation homes, and virtually all of it is owned by the International Paper Company; International Paper owns 60 percent of the town of Stratton.

The company has been under fire



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from both Vermont and New York because of a paper mill at Ticonderoga, New York, at the lower end of Lake Champlain. This mill has for many years made a cesspool of the adjacent segment of the lake. A new plant may reduce insults to the eye and nose, not to mention the lake, but pending its completion, sulfite sludge keeps pouring into the water. International Paper's local reputation as a conservation-minded organization is minimal.

IPC has excellent corporate administrators. They recognized that their holdings in southern Vermont were Green Mountain "gold," not because of spruce for pulp or yellow birch for cabinet veneers, but for land development. They realized that IPC had no knowledge of land development and that it would be useful to acquire a company with such experience. Thus, in 1968 IPC put out $12 million to acquire American Central Company, a Michigan-based firm that had developed about seventy tracts in nine states. According to *Fortune,* IPC incidentally generated a tax write-off by transferring land to their wholly owned subsidiary. The president of IPC, Edward Hinman, said, "American Central has had an impressive record in its ten years of operation for selecting, planning and developing recreational areas of this type." To round out their entrance into land development, IPC purchased Spacemakers, Inc., a Massachusetts firm specializing in the construction of leisure homes ("eight weeks from start to completion") and the interdigitation of IPC land, IPC forest products, and IPC land development was complete.

No one is sure how IPC's development plans for Stratton leaked out, and it is possible that the light of understanding dawned only when bulldozers began clearing the land. Residents became alarmed in late June about the instant community and transmitted their fears to state senator Edward Janeway and Governor Davis. Davis immediately telegraphed Hinman, IPC president, for a meeting. A local officer of the company first presented the over-all plan to a state commission in late June, 1969. Asked what would be done about water and sewerage, the IPC official replied that each lot owner would drill his own well and

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install his own septic tank. Asked by a representative of the Vermont Water Resources Department about tests for septic tank feasibility, the official said that no tests had been made. Asked about open space, the official replied that some land would be left undeveloped, but admitted that some of this is "rather on the steep side." Asked about building restrictions, he replied that none were contemplated. Asked what responsibility his company would assume for sewage treatment plants and a community water supply, he replied that a council of citizens might be formed to study community problems. Asked if IPC or American Central would ante up a bond to pay for emergencies brought about by the development, he replied that he couldn't speak for the company. At the end of this meeting someone passed around a brochure of an American Central development in Wisconsin that showed a lake completely surrounded by 60- by 150-foot building lots. Senator Janeway later admitted that he shuddered.

Shortly after this interesting session, the Stratton Planning Commission met with a citizens' group, the Vermont Natural Resources Council, to point out that tiny Stratton was unequal to the task of controlling the mammoth IPC combine. One commissioner said that the company was able to hire all the lawyers around and had even invited local selectmen to go on the company's payroll as consultants. One local conservationist reported that he was warned to get out of the way or he'd be run over when he tried to take pictures of operating bulldozers, but he hired a plane and took his photographs from the air. According to people who attended the meeting, the pictures show a hunk of land cut by roads from bottom to top, with virtually no thought of water flow or other ecological considerations.

Hinman and Governor Davis met on July 12 in a closed-door session with the Environmental Control Commision, but by the end of the session the state was no closer to learning any details of the plans than it had been two weeks earlier. Hinman did say, in a press release, that his company had only the best interests of Vermont at heart and that American Central would work closely with local and state officials during the development of its 23,000 acres. On the basis of this meeting the governor said the relationship was starting off as one of the finest cooperative ventures ever undertaken with a developer.

Over the weekend, however, a completely new view of American Central came to light. Elbert Moulton, special assistant to the governor, made an incognito visit to Tamworth, New Hampshire, where American Central is developing a ski and beach club on a small lake. Moulton was greeted at the entrance by a full-dressed clown, complete with balloons and streamers, who waved and beckoned to drivers. Posing as a prospect, Moulton got the hard sell, with a "weekend-after-the-Fourth-of-July special," promises of no lower limit on cost of home building, favorable financing, and all the rest. The company advertised in Boston newspapers that there was a lake with a natural sand beach, but the saleswoman admitted that they had been hauling in sand for the past week. Moulton, no slouch as a salesman himself—he worked out the "Vermont, the Beckoning Country" campaign—admitted that he beat a hasty retreat. In a report to the governor, he concluded that if American Central were to develop in Stratton as it has been developing in New Hampshire, Vermont should not allow it. At the press conference the Friday before, neither the president of IPC nor the president of American Central admitted that they even knew that American Central was developing in New Hampshire.

Within two days, things really began to pop. On Wednesday, Governor Davis announced that development of Stratton by American Central had ceased pending revision of its plans, that the IPC vice president for public relations would meet forthwith with the governor to establish closer communications, that aides of the governor would visit other American Central projects within a week, and that the president of IPC had expressed concern over the type of development being done by his firm in New Hampshire. Local newspapers printed unattributed stories saying that International Paper was not aware of the building habits of American Central prior to its infolding into the corporate bosom, and that IPC now realized

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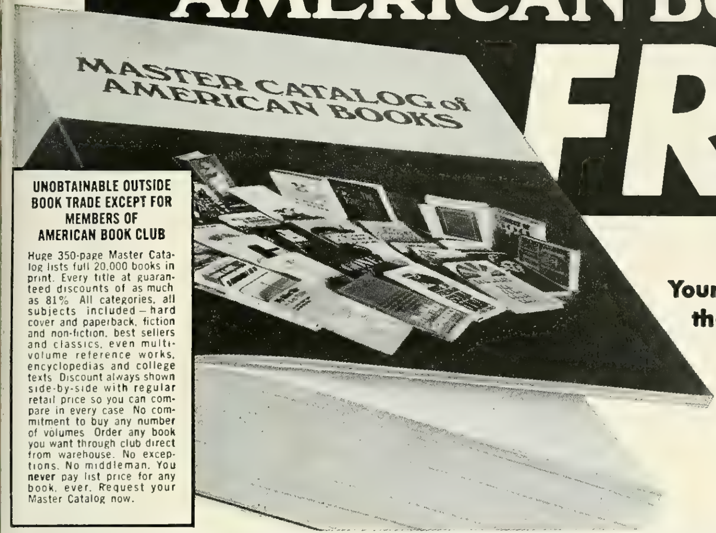

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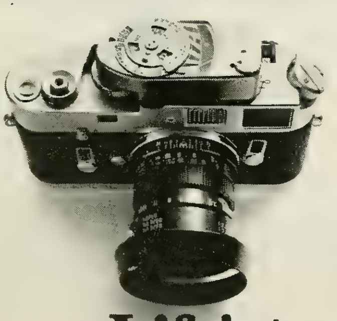

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that it had misjudged public reacti to its Stratton development and ha erred both in its public relations an in its reluctance to discuss thing frankly with the Environmental Co trol Commision the previous wee Although IPC admitted that the Ne Hampshire operation is tawdr they stated that it is not the best e ample of American Central's wor Unfortunately, reports are alread filtering in that American Centra developments on Cape Cod and else where are at the same level.

On July 25, Stratton resident finally learned officially that muc of the township would soon becom a community of one-acre lots—1 percent down and seven years to pay The meeting got off to a bad start because American Central didn't sho up and a messenger had to be sen up to the mountain to bring a representative down to the meeting. Whe the townspeople asked for some assurance that American Central would do right, they were told that the development would be a "welcome addition to your town," and that "our company's past record is spotless." It didn't allay their fears to be told that any jump in school-age population would be the concern of the local school board, that the township would double or triple its population in a few years, that 12 miles of roadway are being built for the town to take care of, or that expansion is virtually certain within the next three to five years.

At about the same time, Governor Davis asked a professional planning consultant to meet with American Central to insure that Stratton would be a quality development. By the end of the week, all work was halted pending extensive review and evaluation of the entire operation by state advisers, and by the end of the month, it was announced that plans for the development would be shelved until at least the spring of 1970. The governor hinted that IPC may decide that the development might simply not be worthwhile because of the unfavorable publicity and the adverse reactions of local citizens.

The purchase of large tracts during 1969 has not been restricted to southern Vermont. Interstate highways will soon complete the network between Massachusetts, Montpelier, the state capital, and the Canadian border. It is a short drive through

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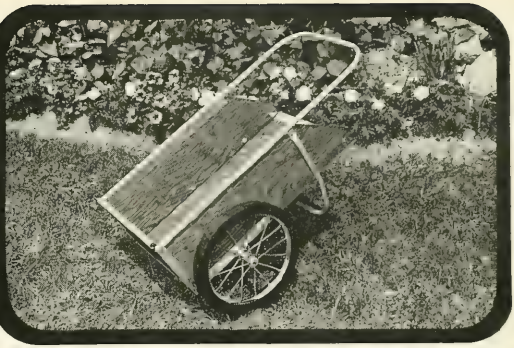

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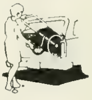
 Is it shaped to take a great big cardboard box for leaves and other such bulky loads? **YES** ☐ **NO** ☐	 Can you load it crosswise without having the load slide off forward? **YES** ☐ **NO** ☐	 Is it light and compact enough so it can be easily lifted, by non-giants, into a station wagon, for example? **YES** ☐ **NO** ☐
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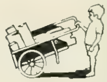
 Will it "stand on its head" to accept heavy loads, so you don't have to lift them? **YES** ☐ **NO** ☐	 Are its legs out of the way so they don't constantly bang your heels or shins? **YES** ☐ **NO** ☐	 Is it designed so you can balance a heavy load with just one finger, and so the axle carries the load, not you? **YES** ☐ **NO** ☐

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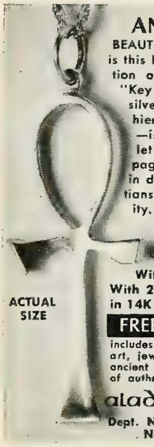

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lovely country into the whole northern part of the state, including the hitherto neglected "northeast kingdom." In one of the kingdom's counties, Essex, 90 percent of all land is owned by lumber companies. Caveland Equities, Inc., also directed by Eugene Coleman (who started Dover Hills), purchased close to 3,000 acres in the kingdom for about $100 per acre—a dirt cheap price. Mr. Coleman, a busy man who keeps his money working hard, also purchased 800 acres on yet-unspoiled Lake Seymour, and 2,700 acres in Greensboro. Some undisclosed group apparently took the trouble to look at a recent state highway map (free from the Vermont Development Commission) and purchased 1,600 acres near Interstate 89 in the town of Sharon. A parcel of about 30,000 acres was sold by a financially depressed lumber company to Laird Properties and Laird's New England Land syndicate added about 40,000 acres within a few weeks. Names like the "Great Northern Land Corporation," "Triton Investments" (a California combine), and several ". . . and Associates" are beginning to crop up on the list of purchasers of large acreages.

An interesting sociopolitical note to the burgeoning land speculation in the northeast part of the state is the separatist movement in Quebec. Many of the Anglo-Saxons (anyone who is not French) have money, and this is part of the reason for the agitation. They are beginning to hedge their finances by heavy buying in those areas of Vermont and New Hampshire within 75 miles of the border and are paying not only inflated land prices but also an unfavorable exchange rate of 7 percent.

Many townships have no zoning regulations and, of those with zoning, many have either interim regulations or, as in the case of Dover and Stratton, minimal zoning. Mere zoning doesn't insure sewerage systems, adequate road construction and maintenance, school sites, a municipal water supply, or even conservation of open space. These are the functions of subdivision regulations, and very few towns have even started arguing about them. Ultimately, direction, power, and naysaying rests at the state level because the towns haven't the money, men, experience, or hometown power to cope with the situation. One official of a prominent development company noted that Vermont is a Mecca for his and other companies just because of this.

The realization that something had to be done immediately caused some soul and law searching in state offices. The secretary of state revealed that a 1917 law gave him the power (hitherto unused) to refuse to license any foreign corporation if the refusal would "promote the general good" of the state. Foreign corporation is defined as a firm whose principal place of business is outside Vermont. It was also suggested that municipalities could refuse to take over the roads put in by developers. This would certainly hurt sales because a potential buyer would understandably be loath to purchase property knowing the roads would not be plowed and maintained in the winter. A simple amendment to existing law would require only that the street or transportation portion of the master plan require approval before any work can start.

Up to this year, Vermont really didn't have an integrated system for regulation, not because previous administrations were unaware of the dangers, but because there was real citizen resistance to imposition of state control. This past summer several local boards informed the state in no uncertain terms to keep its nose out of their communities—they could handle their own problems, thank you very much.

Archaic practices worked against effective control. The tax department was not permitted to inform other state agencies when a large tract of potential development land changed hands. Fish and Game, Forests and Parks, Water Resources, Health, Planning and Development were separate and unrelated. Central Planning could act only when requested by Development. Highways, responsible for many winter road services, could assist a town only when invited. The list could be extended for another half column.

Vermont does have laws regarding pollution, but like those in many other states, they are ambiguous, full of loopholes, and subject to "interpretation." It hasn't helped that two involved departments, Health and Water Resources, were independent and not especially cooperative. A key

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section of the Water Pollution Control Act states that the Water Control Board may take action against any person who permits wastes to enter water so as to reduce the water below the classification set for it. Another law provides that any person who diverts water (such as drilling a well) and either corrupts it or renders it impure is liable to the municipality. At a hearing last year the water resources commissioner stated that he didn't believe (but didn't know) that the board could press a case against a mass developer. When asked what would happen if he did seek an injunction, he stated that he thought (but didn't know) that the law allowed him to act only after pollution has set in. He was challenged to determine the legal extent of his power, but he didn't try. The commissioner knew that he could assist in design and had to approve town plans for both sewerage and water, but he didn't believe (but didn't know) he could regulate a development's plans unless they were submitted by the town.

The health commissioner admitted that Vermont has many laws that provide for regulation, but he noted that he doesn't have the staff or the money for environmental control. Some time back the commission won an injunction forbidding construction of additional homes on a site that couldn't support more septic tanks, but it hasn't taken advantage of this precedent. Health officers said they really don't get complaints until after damage has been done, but I can show you water and health hazards a half hour from my home that are older than I am. Obviously, money is a factor, but the prime considerations are motivation and some sense of urgency, and both have been conspicuously lacking. Up to now the people haven't leaned hard on the state because they haven't been aware of the situation.

With the citizens now aroused. these deficiencies are being cleared up by an extensive reorganization of state agencies. Concern for the quality of the environment, shouted for years by the conservation-minded, is now as Vermontish as white rat-trap cheese or maple sugar on snow with dill pickles. We now have an Interagency Council on Natural Resources embracing Forest and Parks, Fish and Game, and several others. In September, a Planning and Community Services Commission was organized to umbrella housing, poverty programs, local affairs, the Central Planning Agency and several others. Not incidentally, it is headed up by Ted Riehle, who fought for and eventually secured the passage of an antibillboard law, only the second in the United States, which will allow all of us to see our mountains without eyeball pollution.

The capstone in any concerted program is an environmental control commission; Vermont established one last summer. Chaired by a legislator with a record of intelligent conservation policy, the commission was charged with making recommendations on new laws, on integration among departments, and on coordination with local governments. Among its first recommendations was one for a 90 percent increase in funds allotted to regional planning groups on the county level, a fiscally, politically, and environmentally sound idea. The commission serves now as an evaluative center for other far-reaching plans. The health commissioner requested the Environment Control Commission to seek legislation that would require all land developers to submit plans to his department for approval prior to any work. He also asked for legislation to give the health department specific authority to move against developers.

Should the state set standards for approving or disapproving certain lands for development? Should Health and Water Resources hire engineers to help towns control land development? Can taxes be scaled to provide advantages if land is not used for development, and what effect will this have on state and local financing? What about pesticide controls, responsibility of town and state for highway construction, protection for lands above 2,500 feet? An important and delicate question is how much authority the state can assume without infringing on local communities. Many argue that local officials cannot be trusted with authority over land development because they have been put on the payrolls of developers, may be in a position to profit personally from development, or are snowed by the high-priced talent at the command of the developer.

In late June, the governor announced that the Environmental Control Commission will form Development Technical Advisory Teams to provide assistance and advice to communities and planning commissions. Happily, the commission was flooded with volunteer expertise, including nationally known regional planners, a professor of zoning laws, and others who are either "instant Vermonters" or "sunshiners" (owners of vacation homes). Economists, ecologists, and other academic types are also available to the communities—not that they weren't before, but few ever asked for their help.

Apparently, the response has been excellent. The town of Wilmington, just south of Dover, asked for a Technical Advisory Team within a week or so after the teams had been set up. A few days later the Stratton Planning Commission sent in an SOS. There are indications that at least some of the developers will avail themselves of these services. In fact, the promulgation of new health-safety regulations that require testing for percolation, groundwater levels, and other basic data will provide, for the first time, a basis for the teams to work effectively. A proposed revision of the sanitary engineering regulations, subchapter on subdivisions, provides the teeth to bite off the outstretched fingers of greedy developers.

I am usually unsatisfied by upbeat endings. Lovers wending their way into the sunset to swelling chords leave me cold. And yet, a colleague who has been deeply involved in Vermont conservation recently told me that he has never been so optimistic about the cause, and I respect his judgment; he has more battle scars than a Roman gladiator. If there is light at the end of this long environmental tunnel, it is the result of the long-overdue realization by Vermont citizens that the "beckoning country" must exist for the future. In a lecture about two years ago, William O. Douglas, a mean infighter for conservation, said that only the people can save their environment, and only if they will support those who have long cried in the wilderness, and only if their wishes are made clear to their elected representatives. These case histories in Vermont tend to support his contention. But public opinion and public support are fickle things. . . . ■

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by Stephen W. Hitchcock

The tide comes seeping in over the marshes. If we watch, the water remains in quiet pools moved only by an occasional breeze. If we return to our work and then turn once again to look, we find the water has extended its great arms up valleys and indiscernible hollows, forming great meadows of water. The once quick-flowing river is turned into a shallow lake that pushes its way up to the fence posts guarding the hay fields. At the point of victory, when it might overrun the fields, the yards, and the road, it pauses and then—so slowly we can only measure it by successive sticks pushed into the ground—it retreats. Our world is safe for now. The marsh snails move down the grass stems, the mussels close, and the fiddler crabs await the next tide, vainly hoping to march through our kitchens on a flood of brackish water.

The male fiddler crab is easily recognized by his large claw. Surely he must be a fierce denizen of his miniature world, but no—this claw is used to attract females to his burrow or to fence harmlessly with other males during mating season. He uses his other, moderate-sized claw to pick up the bits of organic debris that he feeds on. The fiddlers burrow into the mud flats and salt marshes, their holes speckling the mud. They do not always stay in their burrows, however, but wander about at low tide searching for the tidbits of life and retreating when the tide comes in.

In early summer the fiddlers mate, and the female carries her thousands of eggs under her abdomen until they hatch in early fall. The larvae float with the plankton of the tides until the following spring, at which time they resemble the adults.

Subject to attack by herons, gulls, and raccoons, and used for bait by man, the fiddler lives with the rhythm of the tides and seasons, scavenging the tidal flats and in season, beckoning to any passing lady love. Not bad, for a crab.

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My neighbor, Art Schneider, is a young man, but the reminiscenses of his youth come from another age.

"There are still ducks around, but it's not what it was a few years ago. We did what we called 'creek jumping'—starting at one end of the marsh, we'd walk through and jump anywhere from one to a dozen in a bunch. We'd start south of the cemetery. Mr. Lewis kept hunters off his land north of that, and Hammonassett State Park was posted, except for a section along the river's edge. In the park you had to use one of the state duck blinds.

"If there is a straight piece and then a twist in the creek, there'll almost always be ducks around the corner. If one person goes ahead and circles around below, the one trailing gets a shot and drives them over the guy below."

There are many other things in the marsh. To a young boy hunting or exploring, it is not the monotonous expanse it might seem to the visitor who stops his car on the uplands for a moment's glance. There are creeks, meadows, cattails, and holes—all different, each with its own life and anticipations.

"My brother Dick trapped for muskrats. As a boy that's the way he made his spending money until synthetics ruined the market. He'd get thirty to forty skins a month. Our father would call up an old man by the East River or a guy in Westbrook to see who was buying. The skins had to be perfect to get the best price."

"What happened to most of the ducks on the marsh?"

"Oh, probably hunting pressure and pollution. During hunting season the ducks fly out to Long Island Sound early and come back late unless a storm drives them in. A few years ago there were no factories

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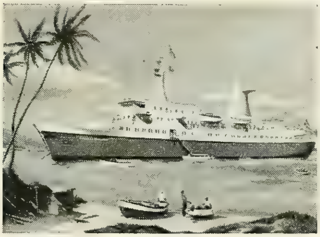

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here and no oil in the water. There used to be a lot of blue crabs. Some think the metal from the wire factory drove out the crabs."

During hunting season, we still hear the bangs of shotguns.

"You've got to get there before dawn to be ready, or late in the afternoon as they come in. Usually in the afternoon there's nothing. Late in the season, once the ducks are jumped, they take off. But early in the season, if you jump them, go down into the creek bed and wait. The ducks often circle and come back and you can get an overhead shot. Generally though, the first walk through in the morning gets all. If there is a hunter ahead of you, you might as well not bother. First come, first served."

"What do these people want? They can't save the whole shore. The salt meadows don't do any good. Neither me nor anybody else wants to live there. It's nothing but mud and mosquitoes. The only real use for it is marinas and that's the highest value land use. That makes sense. More and more people are buying boats, and they have to have a place to put them. How many people do you see down on the marsh now? A few bird watchers maybe. If they want to bird watch on it, I don't care. I've got better things to do than that, but I don't tell them what to do. Why are they trying to tell me? Which do you prefer, birds or people?"

Plant life in the tidal marsh is determined by fluctuations in the amount of fresh water, by intrusions of salt water, and by the contours of the land.

Tidal marshes did not excite general scientific interest until 1950 when Frank Egler, the Peck's bad boy of ecology, in collaboration with W. R. Miller, did a study of a Connecticut marsh. Part of this interest may have been due to Egler's prejudices and pungent style of writing, a rarity in scientific literature. "Existing marshes have been lacerated with ditches with that admirable thoroughness and pseudo-foresightedness with which mankind is apt to treat the lands of his heritage."

Egler and Miller characterized the different areas of the marsh and suggested explanations for various natural features. For example, pans —shallow depressions with a stunte flora—developed when brackish water was trapped on a receding tide The water then evaporated, leavin a salty residue that killed all but th hardiest plants. But even where i was saltiest, something survived—th lowly glasswort.

Salicornia—glasswort, samphire or pickleweed—is a low fleshy plan that looks something like a cactus. I is found in saline areas, not becaus it prefers or grows better in such regions, but because it can live where others die. In the low, flat pans, where the sun beats down and the salt crystals form, the glasswort thrives. Glasswort can germinate at higher temperatures and higher salinities than most other plants. The fruiting head of English *Salicornia* can float on sea water for three months, be cast up on the shore at high tide, and the seeds will still germinate.

In the fall, glasswort compensates for its inconspicuous spring flower by turning a deep red that gives a sheen of color to the marsh.

The possibilities of this plant do not end here. The young tender shoots can be used in salads. Older plants may be pickled in vinegar and used through the winter.

No more can be asked of a plant.

It was low tide and several clam diggers were busy stirring up the sand and mud. I looked for the man with the most clams and walked over. He was short and stocky, and dressed in a dark blue sweatshirt dirtied with the sand and mud from his digging. As we chatted, he rarely glanced up, except to keep track of his children running up and down the strand. Other diggers moved aimlessly about, digging here and there, but this man worked methodically forward over a small area. As he bent over the two-foot handle of the clam rake, his arms moved rhythmically up and down with short, chopping strokes. Every few seconds he dug rapidly deeper. The long siphon tube of a clam would start to withdraw, but with a few strokes he would unearth it, adding one more clam to the growing pile in a wire basket.

"You are getting more clams than all the rest put together," I said, hoping to unearth some secret.

“They haven't been going clam-ing for forty years.” He pushed nd over a small, rejected clam, ex-laining, “the gulls eat them if ey're left out.” He resumed chop-ing. *“They* leave them out,” he said, odding toward the dilettantes pok-g about with their clam forks.

“Don't all the clams get dug out n a small beach like this?”

“They try it once or twice and ive up. I started when I was seven. e used to clam all down the shore.”

He straightened up and looked own the line of piers, boats, and acks toward the tower of a pile river down the harbor. “Way down there. We used to get clams down ere when I was seven. All the time. lot of people did.” He glanced at is children and resumed digging.

One of the dilettante diggers came y. “There aren't any clams back ere,” he said and began cautiously igging five feet away from the man the blue sweatshirt.

“There's clams,” said the clam igger. He worked around so his ent-over bottom was facing the ilettante, who moved away to the ose, dry sand higher on the beach.

“Is there a size limit?” I asked.

“Inch and a half,” he said, re-overing a 2½-inch clam with sand.

“There's enough clams here.” He eemed insulted that the other dig-ers were finding clams so slowly.

“Perhaps it's just as well the others ren't finding many. The clams ight get all dug out.”

“They won't be back next week-nd. When I was little we used to dig lams for $.25 a bushel.” The mem-ry seemed to give him pleasure. My wife is going to fry these. That's he best way.”

“How about the sand in them?”

“Just in the neck, but we split the ecks to fry them and clean it all out. f you want, you can hang them in a asket in salt water for three or four lays and they'll clean themselves.”

“You make it look too easy,” I aid, looking at his basket mounded vith clams. “Makes me think I hould start digging myself, but I uess I'll settle for buying them.”

“Where can you buy them?” He icked up two more. “I like clams,” e said, never pausing in his dig-ing.

I turned to resume my walk down he shore.

Continued on page 72

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Echolocation In Bats

Many bats "see" the world around them solely by hearing and analyzing the echoes of their own sounds

Photographs by Nina Leen

Text by Alvin Novick

Most of the conspicuous bats of temperate climates leave their daytime roosts en masse at dusk and immediately begin their nightly pursuit of insects. But in the tropics, bat populations emerge more or less sequentially, often long past dark. In the case of Mount Plenty Cave in Jamaica, for example, *Monophyllus* are followed by *Chilonycteris. Artibeus* and *Phyllonycteris* emerge later. In Mexico I have often noticed that vampires are the last to emerge, sometimes as late as 10:00 P.M.

Watching bats in tropical caves in late afternoon, one sees increasing preening and hears additional bickering and vocalizing toward dusk. Then, within the larger chambers, a few bats start flying great circles, during the course of which they pass one or more of the principal exits. More and more individuals join these flights until some hundreds or thousands of bats may be moving together in long swirls. Apparently, as they pass the exits they judge the intensity of light and decide whether to emerge or not. On dark, overcast evenings, bats emerge earlier. They also emerge earlier through exits that are deep in ravines or that are heavily shaded than they do through exits facing the clear sky or open to the west. Emergence time varies, of course, with the time of sunset. (I have found that a cave population can be substantially "bottled up" beyond sunset by placing a single flashlight in the cave exit, shining inward.) Bats awaken in response to a built-in rhythm of activity such as has been demonstrated in a wide variety of other living organisms. Their flights past the lighted exits reset their internal clock, if necessary, and keep it synchronized with the solar day and night. That is, if a bat awakens too early, its clock is reset by its view of full daylight. The next night it sleeps longer and commences flying later.

Flying in a cave in this way, accompanied by the swirl of so many companions, must create serious orientation problems. The noise level includes a multiplicity of odd reverberations of sound from the irregular facets of the walls and ceiling, plus the sound pulses and echoes all the other bats are using to sense their environment. In order to echolocate effectively, a bat must be able to identify the echoes of its own pulses. I now believe that bats flying systematically in their own cave may do so largely by memory. They are exposed repeatedly to the same, essentially unchanging geometry. To memorize this configuration ought not to be a major challenge. In addition, in several experimental situations we have observed what D. R. Griffin has called the "*Andrea Doria* effect": bats may be using echolocation, a sonar system analogous to the radar system used by ships, but in familiar caves they apparently navigate by custom, paying no attention to the echoes. If obstacles are unexpectedly introduced into the environment, bats will crash into them even while producing their normal sonal signals.

Bats that fly in jungle thickets usually have relatively short, broad wings and fly slowly. They generally produce sonar signals of low intensity and short duration, often at a constant frequency. The wing shape seems adapted to slow flight, quick changes in direction, and hovering. In a jungle, the presence of many obstacles makes it more difficult to detect and pursue food objects. The use of weaker sonar signals avoids the reception of echoes from too many objects because it restricts inspection to the immediate vicinity. Short pulse duration is also characteristic of almost all sonar systems when a bat is very close to its target, a common situation in the jungle or among bats that hunt along walls, trees, or near the ground. Short pulses avoid or minimize the frequency of long overlaps at the bat's ear between outgoing pulses and returning echoes.

Insectivorous bats hunting in clearings or over ponds often display the erratic flight paths that have made bats symbols of inconstancy, fickleness, or of an erratic nature. But each change in direction, each dive, somersault, or sideslip indicates pursuit. When capturing insects at the rate of one or two per second, a bat will appear to be flying erratically because of the braking and accelerating that are required. The short flights between insect pursuits are straight or gently curved.

During the night many bats, having fed, will hang up at a nocturnal roost to rest or sleep while digesting their catch. Such night roosts can often be recognized by the heaps of discarded food fragments found on them or by their discrete guano heaps—each representing the habitual return of a single bat to a specific site such as a branch or a rocky overhang. In some cases, fully fed bats may be seen returning to their caves

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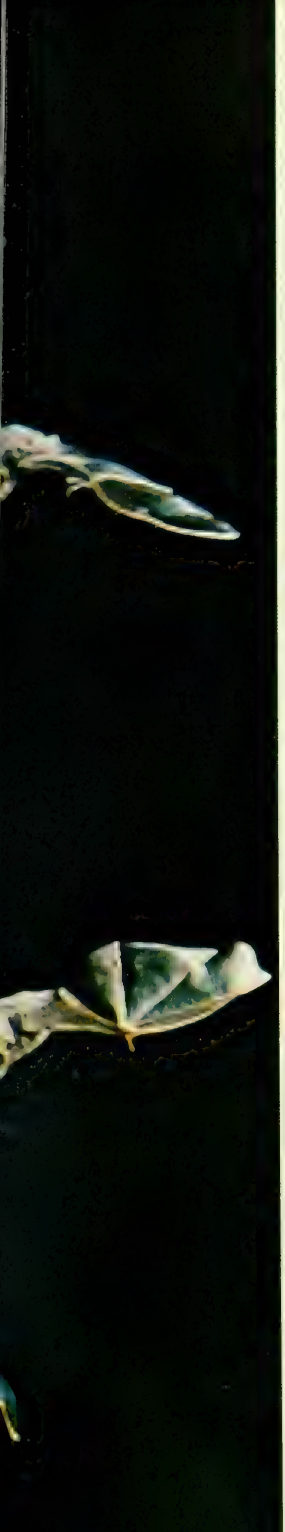
A dog-faced bat, with it
wings fully extended an
symmetrical as they near th
end of a downstroke, appear
to simulate a parachute



In a confined space—where their sonar fails them—bats wheel in confused flight, left. Above, a rousette fruit bat parts its lips to emit the acoustic pulses that guide it.

by 10:00 or 11:00 P.M. In other cases they may be out most of the night, but they almost invariably return before dawn.

Besides flying for food, bats engage in long-distance, seasonal migrations to and from nursery colonies and fresh foraging areas. Such flights have been well documented by naturalists in North America, Europe, and Australia as ranging from 50 to 100 miles up to 1,500 miles or more. In general, the data are derived from banding records of bats that have been captured, banded, and released. In New England bats of several species retreat to Mount Aeolus in Vermont from diverse summering sites in all directions and at substantial distances. We know very little of the mechanics or details of such flights. How, for example, do bats provision for such flights, or do they feed en route? How do they navigate and how do they recognize their goal? What triggers the migrations? Is there a leader? No answers are yet available. Recently several investigators have reopened the question of whether migrating bats may navigate visually by the use of landmarks or the constellations.

Acoustic orientation—echolocation—is the only aspect of bat life that has been investigated in major fashion. In the suborder Megachiroptera only bats of the genus *Rousettus* orient themselves acoustically. They use audible pulses of sound produced by tongue clicking, and depend on echoes from these sounds for guidance in the dark. Producing no sounds in flight, other Megachiroptera apparently find their way by vision and olfaction. How they manage to forage when there is no illumination, or very little, is not known.

Bats of the genus *Rousettus* have evolved a sonar system independently of the Microchiroptera. Insofar as they have been studied, all bats of the suborder Microchiroptera depend on echolocation for tracking insects or other prey and for avoiding obstacles. Those that feed on fruit, flowers, or vertebrates (which emit odors) probably also use olfactory information for local orientation—but their sonar system is nevertheless of prime importance. The Microchiroptera all send out intensely loud, ultrashort pulses of high-frequency sound, which are reflected by objects in their path. We have studied such sounds, from a wide variety of bats, in terms of their major parameters: frequency, frequency pattern, pulse duration, pulse-repetition rate, interpulse interval, intensity, and directionality. In all Microchiroptera that have been studied so far, the pulses are produced in the larynx.

Depending upon the species, the sounds are emitted either through the mouth or the nostrils. Many, if not all, of the bats that regularly emit their orientation pulses nasally have a nose leaf. This appendage may serve either to beam the sounds into a forward, compact, conelike shape or may instead deflect sound from a retrograde path to the bat's own ears. In some bats the nose leaf may even serve to cast an echo shadow of some sort on the ears.

Among the many bats that emit sonar signals orally are some like *Chilonycteris,* the mustache bats, which form their mouth and lips into a megaphone shape when doing so. Generally, they lack a nose leaf.

Sonar signals do not spread in all directions equally. Very little of the sound can be detected behind, above, or below the animal. The greatest sound pressures occur in something less than a hemisphere in front of a bat's mouth or nose. Sound travels in air at about 345 m/sec. and is intercepted by objects in the foreground. In general, objects large enough to be of interest to bats, perhaps 1 mm. or more, adequately reflect the wavelengths being used. Some of the echoes reach one or usually both of the bat's ears. They are perceived and processed by the ears and by acoustic interpretation centers in the brain. The information received appears to be adequate to

flying fox endures a ainstorm, one of the enalties of roosting ut in the open.

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identify the direction, velocity, distance, and some elements of the "nature" of the reflecting surface. We do not yet understand how bats identify the characteristics of reflecting objects by analyzing the echoes. We do, however, have scatterings of solid evidence, lots of clues, and some interesting guesses.

Bats' external ears are not only large but are usually highly mobile. We also know they are highly directional. That is, sounds from certain directions are received optimally while sounds from other directions are partially blocked. Presumably, bats assess the direction of a sound-reflecting object by comparing the perceived intensity in the two ears. In ambiguous cases, they can make a series of judgments with the ears and head in different positions. We know that this method is used by at least some bats. Reception of a sound either slightly earlier or at a slightly higher intensity by one ear than by the other activates other analytical processes.

The middle ear of bats, as of other mammals, conveys sound from the eardrum to the actual sense organ of the inner ear. Two small but active muscles reside in the middle ear. One, the tensor tympani, alters the tension of the eardrum. The other, the stapedius, alters the posture of the stapes on the membranous material called the oval window, which lies in the bony wall of the fluid-bathed inner ear. In all mammals, these muscles contract when extra-loud sounds are heard or while the animal itself is barking or speaking, yawning or swallowing. Their function seems to be to protect the inner ear from disruptive stimulation. When the muscles are contracted, the transmission of sound is diminished. In bats, we know that the middle ear muscles contract before each sonar pulse is emitted and apparently serve to attenuate the intensity of each outgoing pulse that reaches the bat's own ear. But the muscles usually relax in time for optimal echo reception.

From the beginning of modern bat-orientation studies we wondered how bats could hear faint echoes so quickly after emitting intense outgoing pulses of sound. There are now several answers to this question and more probably still await recognition. Not only do the middle ear muscles favor echo reception by their carefully coordinated contractions, but the ears (the entire encapsulated complex of inner and middle ear bones) are often quite isolated from the skull. In some bats, the otic capsules float in rather loose attachment to the skull, isolated and insulated by fatty connective tissue or by blood-filled sinuses. The isolation from the skull presumably reduces bony conduction of sound from the bat's own larynx and respiratory passages to its ears. It also would improve the isolation of one ear from the other for the assessment of direction.

The orientation pulses that bats emit are predominantly of ultrasonic frequencies. Some sheath-tailed bats produce frequencies audible to man (as low as 12 kHz, or 12,000 cycles per second) along with more intense higher harmonics. Other bats generally produce frequencies above 20 kHz. Men generally hear only up to about 18 or 20 kHz, although young children may be sensitive to slightly higher frequencies. A former colleague of mine reports that in his childhood in India he was often kept awake by the loud and ubiquitous sounds of bats hawking by his bedroom windows. His nurse, with more limited hearing, perennially refused to believe his excuse for remaining awake. But even adults, sitting quietly in a well-isolated room and listening attentively while bats fly by, can hear a faint but clear low-frequency component of the sonar signals—the *ticklaut*. In some bats, cold molossids for example, the *ticklaut* is particularly prominent.

Many bats produce orientation pulses that we describe as frequency modulated. Such pulses sweep downward in frequency, often by about one octave. Vespertilionids, molossids, and natalids, among others, produce pulses of this sort. The exact frequency range varies with species. Among the vespertilionids, sweeps starting as high as 120 kHz have been recorded. The common range, however, is 60 to 80 kHz sweeping to 30 to 40 kHz. The fundamental sweep is often accompanied by a second and even a third harmonic sweep, one and two octaves higher.

Other bats produce pulses consisting of a constant-frequency (CF) portion followed by a brief frequency-modulated (FM) termination. In most of these bats, the CF portion is characterized by at least two prominent components, the fundamental and its second harmonic, an octave higher. There are variations on these patterns. In the slit-faced bats and the Old World false vampires, for example, the short orientation pulses are of constant frequency but with several prominent harmonics.

What determines the frequency range used? Perhaps an important consideration in selecting ultrasonic frequencies is that less interference is found there. Presumably, relatively few interfering sounds—insect songs principally—would be widespread or conspicuous in this frequency band. On the other hand, higher frequency sound is attenuated by air. So perhaps these considerations counterbalance each other.

The frequency of pulses may simply be dictated by the dimensions of the sound-generating organs. The smaller and the tenser the membranes, the higher the frequencies produced. One might guess that small bats (hence small larynges) would produce higher frequencies, but this is often not the case.

In general, one might expect small bats to feed on small prey and large bats on large prey. We do not know if this is true, although there ought to be some such tendency and, if it does exist, then small bat species ought to favor high frequencies, other things being equal. The higher the frequency, the shorter the wavelength. Objects with dimensions of about one wavelength seem to reflect sound especially effectively. At about 30 kHz the wavelength is about 11.5 mm. Few naturally interesting objects would be less than 3.5 mm. in diameter. Spider web strands, an interesting example, are poorly detected by bat sonar systems and several ultrasmall species of bats are reported to become entangled in them. Again, few edible objects for the majority of bats are much larger than 1 or 2 cm. in diameter. Fruit, flowers, and vertebrates are probably detected by a different system, that is, by olfaction. Therefore the range of wavelengths seems roughly appropriate. Of course, large obstacles also have to be detected.

Actually, in their ability to detect objects, bats are not limited to those larger than 3.5 mm. in diameter. Bats of several families have been observed in detail while traversing an obstacle course. Such a course usually consists of a plane of vertically hung wires spaced somewhat less than a wingspread apart. A bat is forced to fly repeatedly through the obstacle plane and its score is recorded in terms of hits and misses. Agile individuals of most species avoid wires with diameters down to 0.08 mm. with better than chance scores. Since such wires are often of the order of one-thirtieth of a wavelength, these are impressive performances.

Students of bat behavior have succeeded in studying insect pursuits or other sequential events in only a few genera. In these, however, we now have some understanding of the functions of pulse duration. In *Chilonycteris psilotis*, for example, the pulses produced during what we call cruising, or searching, flight are about 4 msec. in duration. These bats, when hunting fruitflies in the laboratory, show the first signs of beginning pursuit (by shortening orientation pulses and increasing the repetition rate) when they are about 600 mm., or nearly two feet, from the insect. Sound travels at about 345 mm/msec. A 4 msec. pulse, therefore, has a length in air of about 1,380 mm. Since sound has to make a round trip for the echoes to be perceived, echoes from any object closer than 690 mm. will overlap at the bat's ear with the outgoing pulse. Thus, *C. psilotis* detect an insect or at least have their attention directed to a given insect when their echoes overlap with the outgoing pulse.

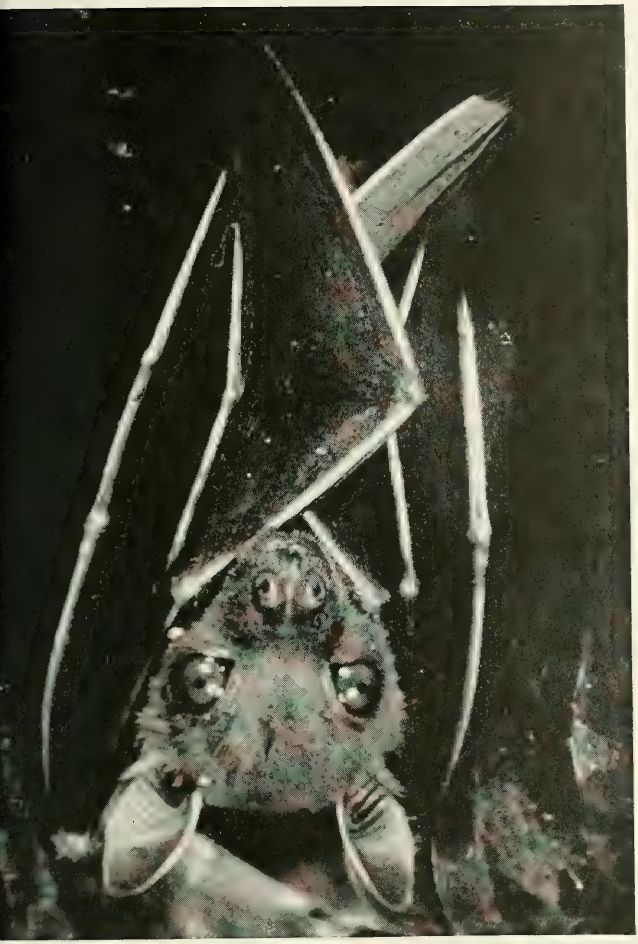
Given a species-characteristic searching-pulse duration of 4 msec., objects will always be detected as being within striking range when they are about 600 mm. away. Such a system means that distance (at least for prey pursuits) need never be quantified or measured. Everything beyond 600 mm. can be categorized as "distant." Everything producing an echo that overlaps with the outgoing pulse would be in a narrow band, perhaps 100 mm. wide, which we might label as "approaching." No unnoticed objects can be closer than this overlap band; they would then have been detected by previous pulses and would therefore have previously fixed the bat's attention. Pulse intensity may be adapted for detecting objects of interesting size at this species-specific hunting range.

Pulse repetition rate and flight speed must also be considered. If *Chilonycteris psilotis* produce about 18 pulses per second, then each pulse is followed by a silent interval of about 55 msec. during which the bat moves forward about 100 mm. Let us assume that the bat had just missed detecting an insect with its previous pulse. Now it emits a second pulse. An object previously just beyond overlap range, that is, 700 mm. away, will now be about 600 mm. from the bat. The echo will now overlap by 0.6 msec. with the outgoing pulse. If the insect is flying directly away from or toward the bat, if the bat's flight speed is irregular, if the pulse durations vary, or if interpulse intervals vary substantially, the amount of overlap and the depth of the detection band will vary, but not substantially. Having detected an insect, *Chilonycteris psilotis* alters its flight path to intercept it, and simultaneously increases the pulse repetition rate and cuts pulse durations. The pursuit and capture of an insect at this range takes perhaps 250 to 350 msec. About 200 msec. are consumed by the approach phase, during which the pulse-repetition rate rises to about 100 per second. The last 75 msec. or so are the terminal phase; now the rate rises to 170 per second or more. The terminal phase is also called the "buzz," which describes our subjective perception when we hear the audible *ticklaut* during a pursuit or listen to a pursuit via a transducer.

In closely related *Chilonycteris parnellii*, search-phase pulses are about 20 msec. in duration. These bats also seem to have their attention drawn to insect targets by pulse-echo overlap, but because their pulses are longer, the overlap occurs initially at about 3.5 m. Pulse duration, therefore, also determines hunting range.

Following detection of an insect at 3.5 m., *Chilonycteris parnellii* first increase their pulse durations to about 32 msec. and then start to decrease them with closing target distance. The initial overlap is about 1 to 2 msec., but after the pulses have been lengthened, overlaps of about 20 msec. occur. These long overlaps, declining to about 5 msec. late in the terminal phase, characterize pursuit in this species. What do such long overlaps signify?

In one experimental sequence, the bat flew across a room to an isolated landing perch. The sequence of pulses in such a landing is similar to that in an insect pursuit. Brain activity was low during the emission and perception of the CF portions of the pulses. Initially, at a distance, the bat may have been plotting the positions of several objects—the perch, the wall, and so forth. As the bat closed on the perch, it seemed to close down the interpulse interval to "focus" on the first of the returning echoes. That is, it was excluding echoes or reverberations from more distant objects. A shallow depth of field, were it to be continued for long, would naturally leave the bat vulnerable, but we are speaking of a period of less than a second. Presumably the bat can open up the interval if there is some reason to do so—such as the intrusion of unexpected sounds or echoes. Thus, in *Chilonycteris parnellii* I believe that the purpose of lengthening the pulses on detection is to separate out two echo functions.



Roosting on a banana leaf, a Malaysian short-nosed fruit bat wraps its wings around its belly and chest. Its feet are in opposite orientation.

First, the CF echo is received and processed, then the FM echo is received (perhaps to assess target direction). The way the bat regulates pulse duration during the approach phase holds these two functions separate and temporarily fixed relative to one another.

In *Chilonycteris parnellii*, during an approach the echo CF would be altered by the Doppler shift, which is imposed by the relative velocities of the bat and its target. The difference in frequencies, if it were being measured, would give a measure of relative velocity. The difference in frequencies might also remove the echo frequency from competition with the output frequency.

Not all bats operate with pulse durations designed to produce pulse-echo overlaps. In addition to the mustache bats, *Rhinolophus* and *Hipposideros* apparently do so. But the vespertilionids shorten their pulse duration during insect pursuits or obstacle course traversals so as to preclude pulse-echo overlap. We do not at present know enough to interpret these different designs.

The orientation pulses of bats are, in an absolute sense, always very loud. The human threshold of hearing at our best frequencies is expressed as being about 0.0002 dynes per square centimeter. This is 1/5000 of the force needed to move 1/25 of an ounce by 2/5 of an inch. The faintest bat orientation pulses known are about 1 dyne per square centimeter when recorded at about 5 cm. from a bat's mouth or nose. Rather loud bats produce pulses at 100 or 200 dynes per square centimeter. These are truly intense sounds, comparable with offensive or even painful noise levels in civilization such as those of subways, jet engines, or boiler factories.

Sound spreads outward from its source in every direction, expanding like an ever growing sphere. Therefore a target of given size receives a smaller fraction of the total sound produced as its distance from the target increases, and less is reflected back toward the source.

Thus the returning echo is faint relative to the outgoing pulse. But the returning echo from objects at appropriate distances is loud enough to be perceived and analyzed by a bat. The output must be sufficiently intense to serve adequately for the ranges and object sizes that a bat works with. Bats that hunt in the open, especially at high altitudes, use loud pulses. Loudness, in general, also goes with long pulse duration, probably associated with long hunting ranges.

Bats that fly in the jungle or in the jungle canopy, also those that fly close to walls, tree trunks, or the ground seeking roosting victims, use relatively quiet pulses. We often call these the whispering bats. Some hunt at short range and thus avoid loss caused by distance. In addition, they conserve energy, reduce the output effect on their sound-processing centers, and perhaps utilize an optimal echo-intensity band.

Other whispering bats do not hunt at short range but appear to be faced instead by an excessively complex environment—vines, branches, leaves, and thorns. I reason that in such circumstances they may gain advantage by reducing output intensity so as to set a limit on the range from which echo information will return. Perhaps these bats can process echoes from three objects at a time or from ten or even more—but there must be a practical limit. By reducing the output intensity, they concentrate their attention on the closest objects and exclude the rest. Such a system, of course, requires slow, deliberate flight so as to preclude collisions with obstacles that have not yet been examined and to assure "seeing" an adequate proportion of food objects before they have been passed by. In fact, whispering bats can normally hover or fly slowly. (Loud pulse bats generally fly swiftly and are relatively unable to maneuver.) Whispering bats also usually use short-duration pulses. Their hunting range is relatively short, and whether they use or preclude overlap, short pulses serve them best.

It may seem strange that I refer to whispering bats after having said that all bats use pulses of high intensity. Those that use relatively low intensities, especially at high frequencies, are technically hard to study. Our microphones, even today, are relatively insensitive in the frequency band of bat-orientation pulses and are often progressively less sensitive as the frequency increases. Thus, bats are termed "whisperers" when we find it difficult to record their output.

The initial studies of the bat sonar system done by D. R. Griffin dealt entirely with North American vespertilionids, particularly *Myotis* and *Eptesicus*. In 1953, he went to Panama to survey the sonar systems of bats of several additional families. His experience with many of the spear-nosed bats (Phyllostomatidae) was frustrating. He was unable to record *any* sound output from several genera. His frustration paralleled that of Spallanzani 150 years before. How could a bat be echolocating unless it was producing orientation pulses; and if it was producing such pulses, why could they not be recorded? We now know that they *were* producing orientation pulses but Griffin's microphones were technically inadequate to record them.

In the next year, I joined Griffin's laboratory as a research fellow newly out of a residency in medicine. I began a series of experiments designed to identify the mechanisms of pulse production. Principally I systematically denervated the muscles of the larynx, the tongue, and the palate in order to localize the sound-producing motor organ or organs. The cricothyroid muscles of the larynx proved to be crucial in the vespertilionids, *Myotis* and *Eptesicus*. These bats, which had had the cricothyroid muscles denervated, emitted audible peeps only and were disoriented in flight.

At that time, we had some examples of the tropical spear-nosed bat *Carollia* living in the laboratory. We had never heard them emit any orientation pulses. I operated on four of them, and we were astonished to observe that *Carollia*, after cricothyroid denervation, were disoriented in flight and, for the first time, emitted audible peeps. Presumably the effect had been the same as in the vespertilionids—ultrasonic pulses had been replaced by useless sonic ones. Some of these *Carollia* survived and several weeks after surgery, we were again astonished to find that one of them was no longer producing audible peeps. On listening with a microphone sensitive to higher frequencies, however, we found that the bat was now producing ultrasonic pulses and was again oriented in flight.

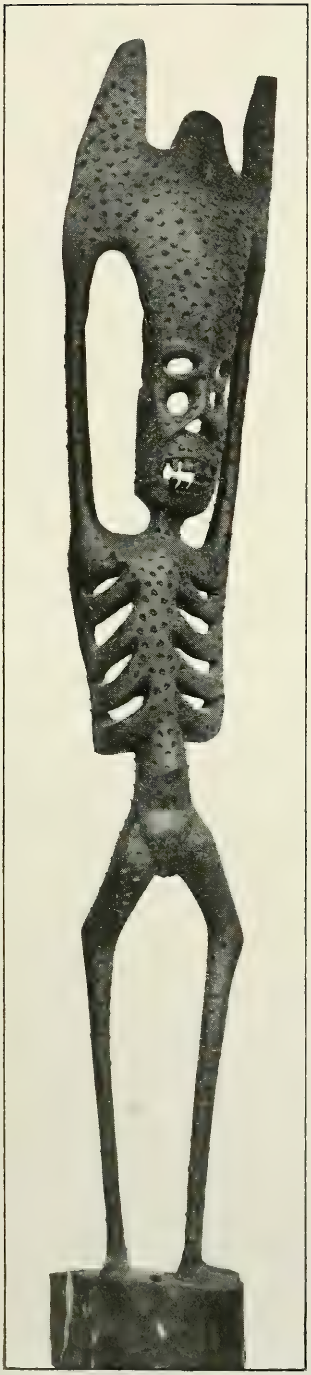
I went to Panama briefly that summer and confirmed these observations on *Carollia* and several other phyllostomatid genera. They were all producing technically elusive ultrasonic orientation pulses. Dr. Griffin and I published a paper in 1955 describing these pulses as best we could, but our descriptions and analyses became obsolete in 1956.

In those days any significant advance in acoustic equipment often rendered recent experimental findings completely out of date. In the fall of 1955, for example, I collected and studied the bats of the Old World tropics. In the course of ten months I worked in the Philippines, Ceylon, and in the Belgian Congo. I undertook the trip although technically I was no better off than I had been in Panama the year before. About five months out, when I was in Ceylon, I heard from Dr. Griffin that he had had a new microphone built from plans that had recently appeared in an acoustical journal. He airmailed the microphone to me, along with its necessary power supply and other accessories. The new microphone, I discovered on the first day, made almost everything I had previously accomplished obsolete. My Philippine observations were irretrievable but I decided to restudy all the bats that I had previously covered in Ceylon.

The new microphone made it possible to record higher frequency and lower intensity signals than previously, as well as the output of many whispering bats when they were in flight. Previously I had had to hand-hold them directly in front of the microphone, risking the production of all sorts of artifacts. Despite the existence of even better microphones today, many questions still remain unanswered.

Improved equipment and research on echolocation in other organisms, including certain genera of birds and several marine mammals, will help answer some of these questions.

In the light of a pale moon
free-tailed bats continu
the daily exodus from Bracker
Cave in Texas that begin
in full sunlight. The cav
population totals 20 millior
adults during the summer



Masklike female figure depicts death.

MAKONDE SCULPTURE

by Megchelina Shore-Bos

If you want to know who I am,
examine with careful eyes
that piece of black wood
which an unknown Makonde brother
with inspired hands
carved and worked
in distant lands to the North. . . .

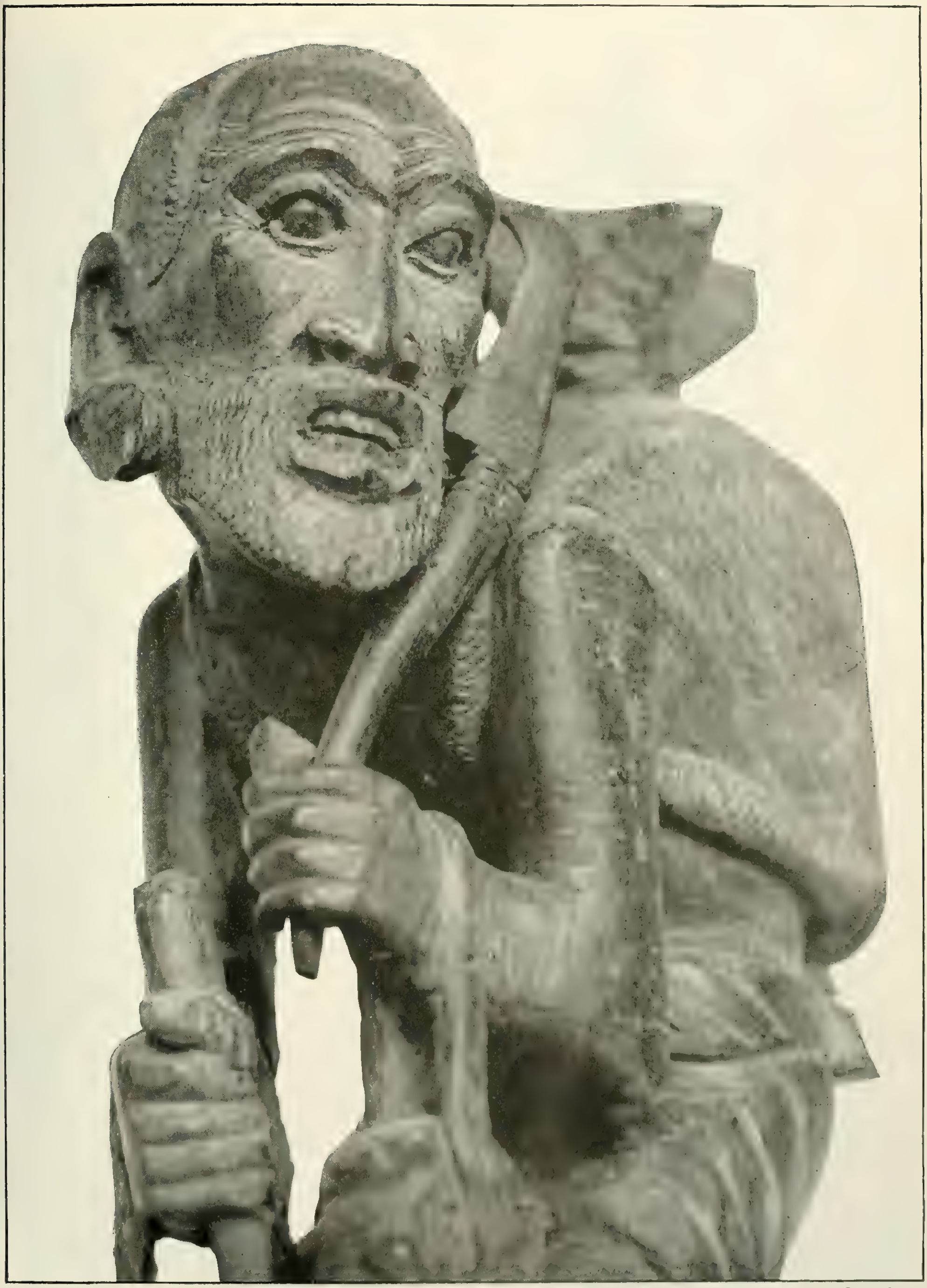
Mozambican poet Noemia de Sousa pays tribute here to a little-known but important tradition of African art and to the people who gave it birth—the Makonde. Today, in the midst of the curios that clutter the streets of Lourenço Marques, Dar es Salaam, Nairobi, and other East African cities; in the welter of cheap imitations and made-to-order carvings that fill the so-called African art shops, the mastery of Makonde sculpture is being discovered.

Before their conversion to Islam or to Christianity, the Makonde practiced a form of ancestor worship. Their art began as a part of this worship. Carvings of mother figures were based upon the ancestral woman from whom the tribe sprang, and who, the Makonde creation myth tells us, was herself a carving transformed into a human being.

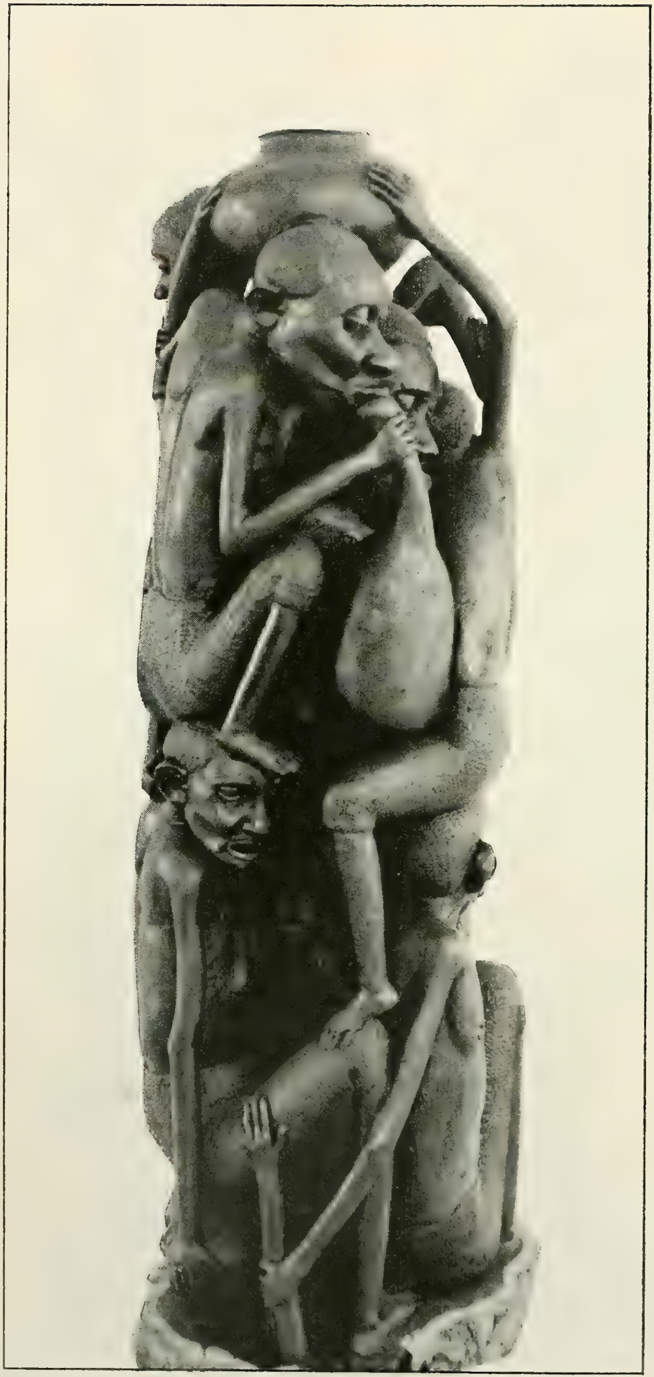
In the beginning, it is said, an unkempt creature, the primordial human, walked the earth. He lived among the rocks by the river, and his ways were the ways of the bush. In time he became lonely, so using a crude knife he carved the figure of a woman from the wood of a living tree. When night came, he placed it on the ground before his lair. At sunrise the next day, he found the figure had become a woman, and from their union the first Makonde was born.

The Makonde live on the northern plateau of Cabo Delgado Province in Mozambique and across the Rovuma River in the Newala District of southern Tanzania. For a long time the Makonde plateau in Mozambique remained relatively unknown to Europeans. Since there were no natural harbors on the coast immediately south of the river, the southern bank never became an African or Arab trade route, as did the Tanzanian side. Mysterious and dense as the plateau may have been, it never gave rise to stories of legendary wealth or rich resources. Waterless and covered by a tangled thicket of bush, stunted trees, and creepers, it had little to attract the settler or the European land speculator.

For the Makonde, however, this was agricultural land. Their crops thrived on the heavy morning dews, and their practice of shifting cultivation produced excellent harvests of maize, millet, sorghum, cassava, pumpkin, sesame, and beans. Water for village use had to be brought from the lower lands, usually by women. Mothers and daughters made the trip, each carrying across her shoulders a long pole with large containers fastened to each end. From the edge of the plateau, they scrambled down a steep and difficult path to the water springs in the marshy bottom, returning with their loads up the almost vertical ascent. Sometimes these trips for water covered ten miles or more.



Carving in traditional style expresses endurance in the face of life's hardships.



Interlocking figures recall the collective spirit of former village society.

It was a difficult life, but the Makonde said that they settled in such a place because they preferred to live in peace rather than in constant fear of raids at the water sources. They also feared epidemics of malaria and other fevers in the marshlands and along the river banks. It is perhaps impossible to say now whether their choice of a home reflected their character or whether that home molded their ways, but they are at once withdrawn and cosmopolitan, a mixture of many contradictory and conflicting characteristics. Throughout East Africa they are known as a fierce and aggressive people who practice witchcraft, eat snakes and rats, and are better left alone. In fact, the Makonde of Mozambique are called *Mawia*, the "angry people." The Makonde dislike this term; yet some scholars believe that they encouraged its use in order to protect themselves from marauding tribes, Arab slave traders, and European invaders.

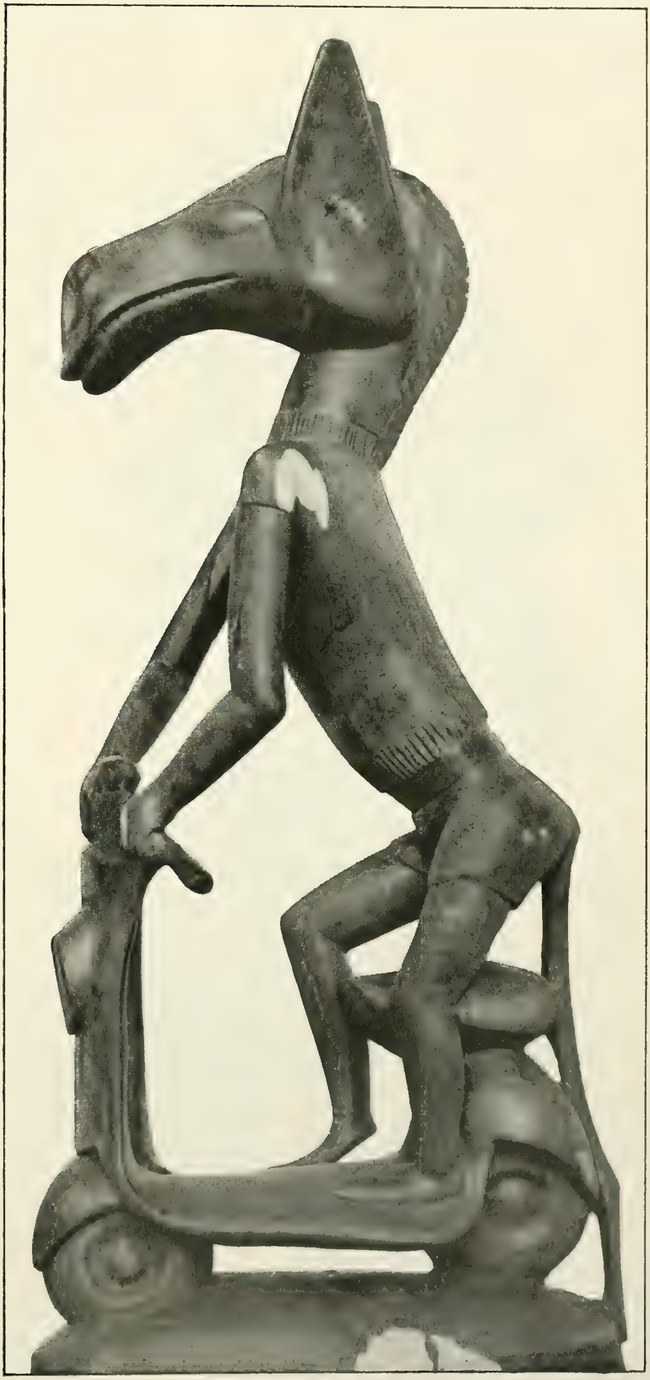
The structure of Makonde society was traditionally matrilineal. Like most of their neighbors, the Makonde believed in witchcraft and sought protection from the spirits and demons who inhabited their hostile, threatening world. The forests and rocky outcroppings were the homes of *shetani*, spirits that could lead a man to his death. Or, they might take possession of him, deprive him of his reason, and transform him into an animal or monster. Nandenga, for example, could assume any human form, and with lightning as his servant, inflict evil on man. A 1915 epidemic of smallpox is attributed to him; traveling from village to village, he spread the disease from a large pot. He is said to have caused the destruction of the Bambarra groundnut crop, and he also brought to an end the use of cassava leaf as a vegetable. Children are warned to stay out of his way and not to tempt him by carelessness or foolishness.

With the coming of Christianity and Islam, ancestor worship and belief in the spirit world weakened considerably. But among older people ancestor worship is still widely practiced, and the younger men and women, even those in towns and cities, believe in it in an uneasy way. The Makonde today live in a somewhat schizophrenic world, a world in which things are falling apart. Their matrilineal, horticultural society was changed by the coming of the white man and colonial rule, which undermined African ideas, beliefs, values, cultures, and customs. Today, Makonde laborers work on plantations, farms, sisal estates, mines, factories, and in the curio trade. In Tanzania they are part of a newly developing nation committed to a philosophy of self-reliance and socialism. In Mozambique they live under colonial rule and commit themselves in increasing numbers to rebellion against that rule.

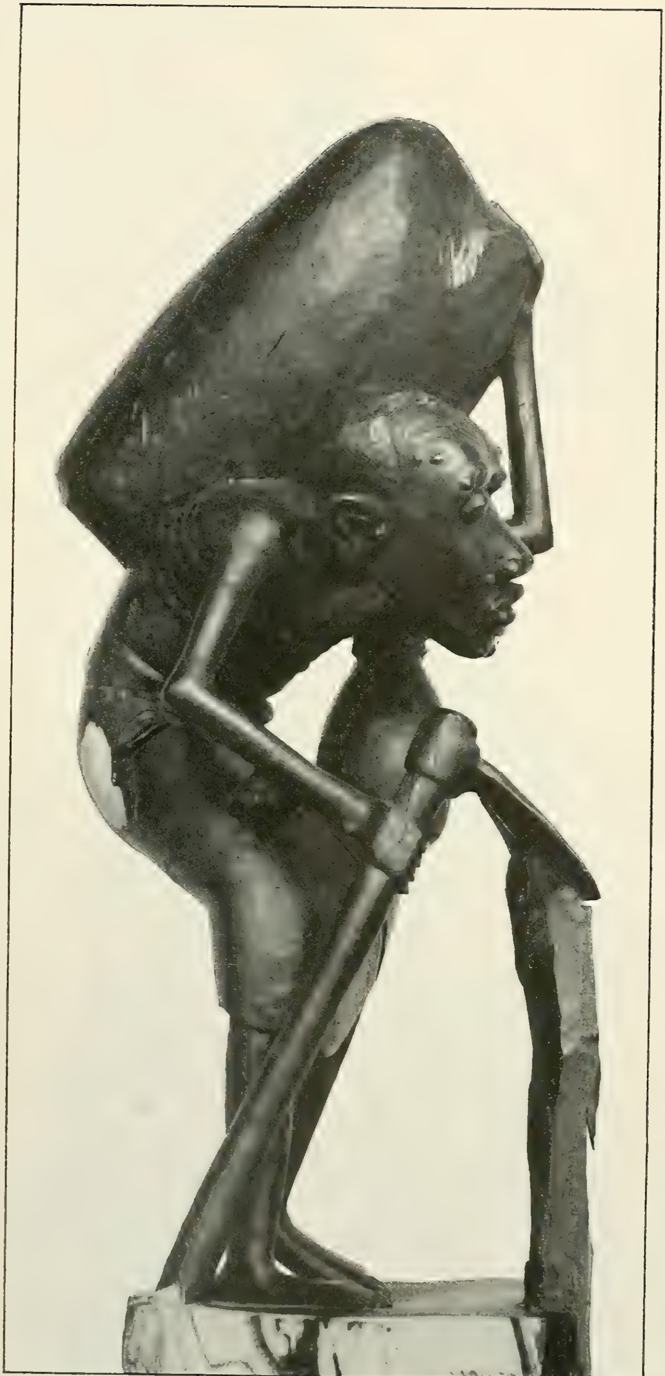
These social changes have naturally affected Makonde crafts, and examples of early carvings—including boxes, staffs, masks, and figures—are now to be found mostly in museums. In contrast to the ebony and other hard woods used today, the earlier sculptures were carved from *njala*, a lightweight, soft wood similar to the cottonwood that the Hopi Indians of America use to carve their Katcina dolls. Makonde masks, however, are still made from soft wood, as are occasional figurines. But time and the tropics have taken their toll, and most of the early carvings have disappeared—victims of insects, fungi, and wanton destruction by colonial administrators and missionaries.

The first carvings were protective figures for the household or for people to carry on their travels. If a man went on a journey or a hunt, he might bind a figure to his back or hip and carry it with him so that the spirit of the mother would look after him. These figures, of various sizes, were sometimes as high as four feet. They were carved in a simple, realistic manner—erect standing figures done in broad planes and stark lines without nuance or subtlety.

Christian missionaries frowned upon the "paganism and idolatory" of this art. Many carvings were destroyed, and the beliefs, values, and customs from which this art sprang



The artist in the city turns his commentary and humor on modern times.



Old man bends under undefined burden—the burden of all men's struggle.

came under fierce and intense attack. In place of local mother images and the figures of the spirit world, madonnas, crucifixions, and figures of the saints were suggested as more suitable subjects, thus adding commercial incentive, too, for these could be sold in the churches and markets of Europe.

Commercialism has made of most Makonde artists either copyists or, at best, virtuoso carvers, able to do in a skilled manner anything that is ordered from them. In such a system truly motivated art tends to disappear. Why should a carver work hard and long on a piece that expresses the beliefs of his people if it will simply disappear into a sea of inferior work? Despite these conditions, the art survives. There are Makonde sculptors of dedication and commitment who produce works of art even as they turn out the curios to earn their daily bread. In their hands, sculpture continues to grow, to develop, and to flourish. They are not to be found in the villages any longer, but rather in the major cities of Mozambique and Tanzania and in the cultural and artistic program of the Front for the Liberation of Mozambique.

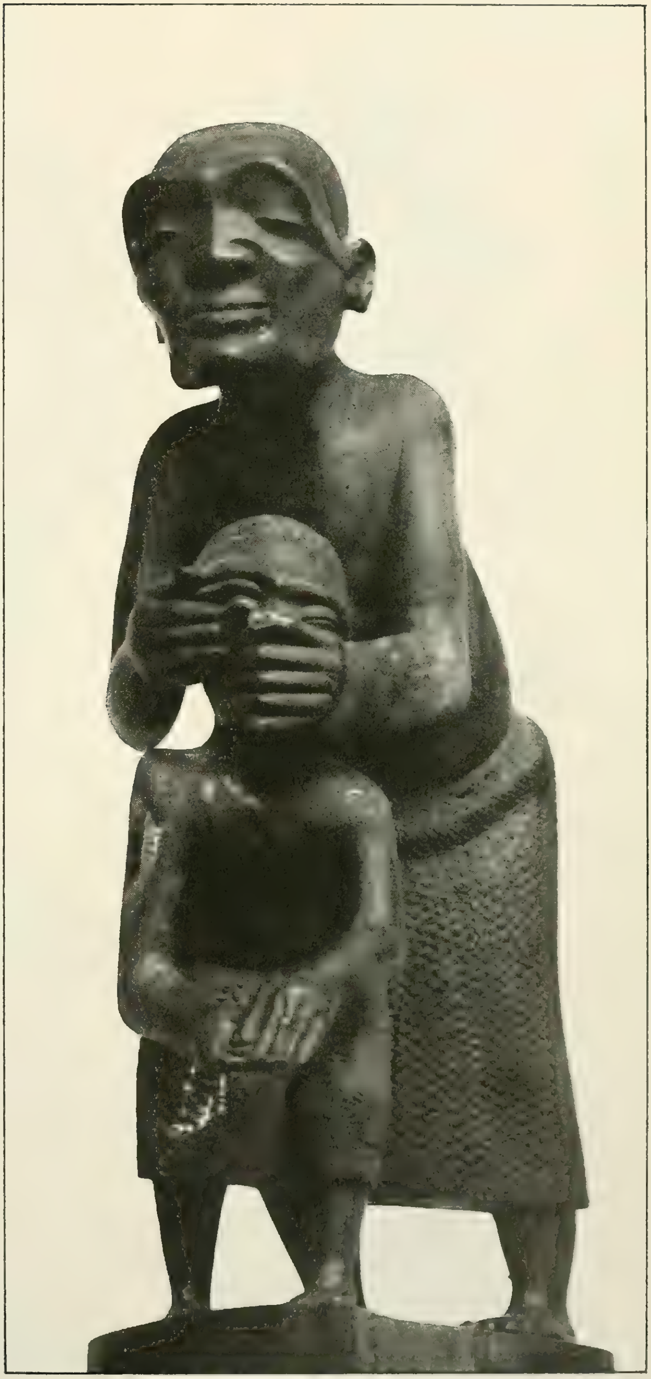
Commercialism and the church replaced *njala* with harder and more durable woods that would withstand time, termites, and the tropical climate. Most noted of these is ebony. It not only transformed Makonde sculptures into long-lasting works of art, but changed the tools and the techniques as well. Hammers and chisels have been added to the knife and the adz. The techniques resemble those used with stone so that the creative process has become slower.

The destruction of village life did not place the artist in a vacuum: rather, the new urbanization, the building of a nation in Tanzania, and the struggle for freedom in Mozambique gave him new themes for his work. Traditional symbols of mothers, spirits, demons, birds, snakes, and other figures were continued from the past, but they began to acquire new meanings. In the changing contexts, new symbols were constantly being chosen.

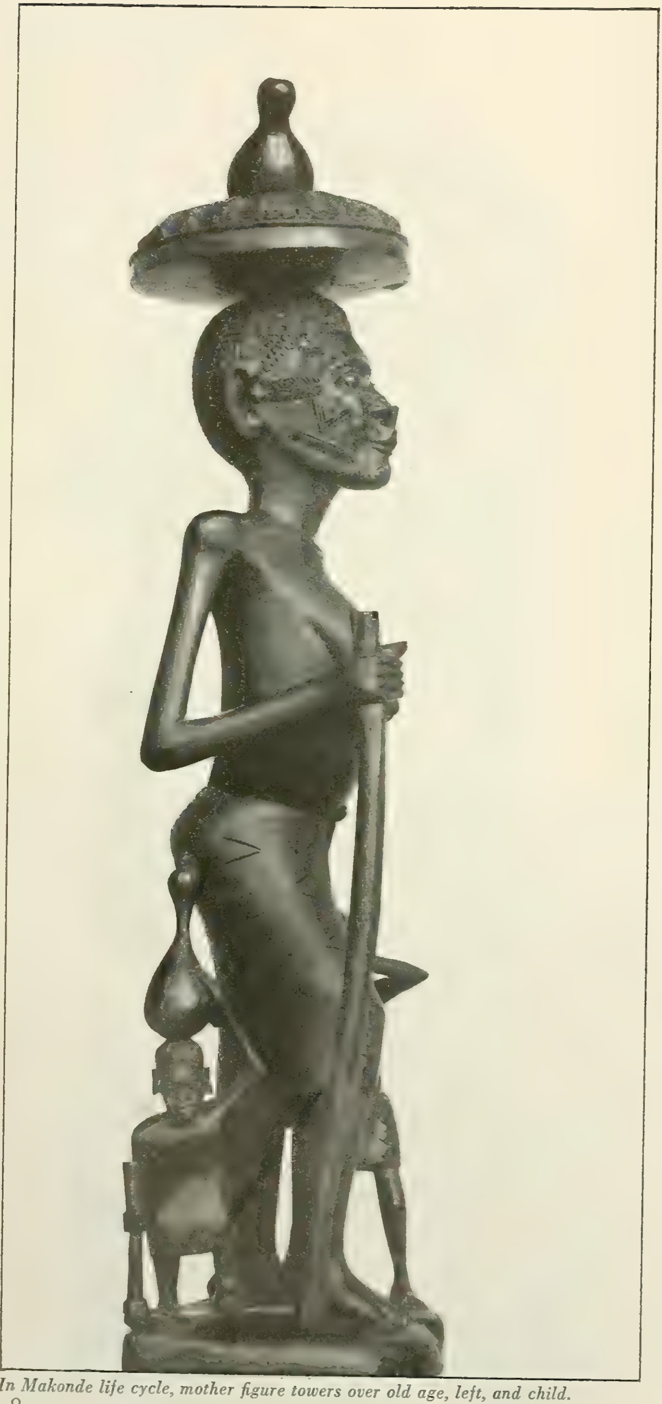
While the tribal carvings of ancestors, the works intended for the education of young girls at initiation ceremonies, and the other carvings made specifically for the people of the artist's own tribe are gone, they survive in essence in the modern sculpture. Mother figures are often the centers of complex, multifigured works. Fears, dangers, and threats are expressed in demonic images. Spirits, devils, men, and animals often lend a nightmarish quality to the Makonde portrayal of the world, reminiscent of the paintings of Hieronymus Bosch.

Modern Makonde sculptors are now creating new and fluid styles, some realistic, others expressionistic and symbolic. Forms flow into forms, expressing the process of being and becoming, and making tangible the constant conflict of opposing forces. To the Makonde, man resolves these conflicts by keeping the forces under control in a kind of dynamic equilibrium. Man, himself, is never statically depicted in the figures as good, evil, noble, or base. He, too, is the moment-to-moment result of the struggle of forces within and without. He is man, animal, and demon. And both men and women contain within themselves the characteristics of masculine and feminine. What man is at any moment depends on which forces are dominant, and this in turn affects his behavior and the judgments by which he keeps contending forces under control. The sex act, for example, has its function —to produce children and assure the continuity, the immortality, of the tribe. In many of the pieces of sculpture, however, it is expressed as lust, transforming man into beast or demon by robbing him of his mind.

The production of children also creates economic and psychological problems for the male head of the household. In the midst of his love for his children, he also experiences feelings of hostility, aggression, even hatred toward them, all based upon a fear of having too many children to look after as the society around him becomes increasingly insecure.



The demon spirit Nandenga unemotionally destroys the vision of a child.

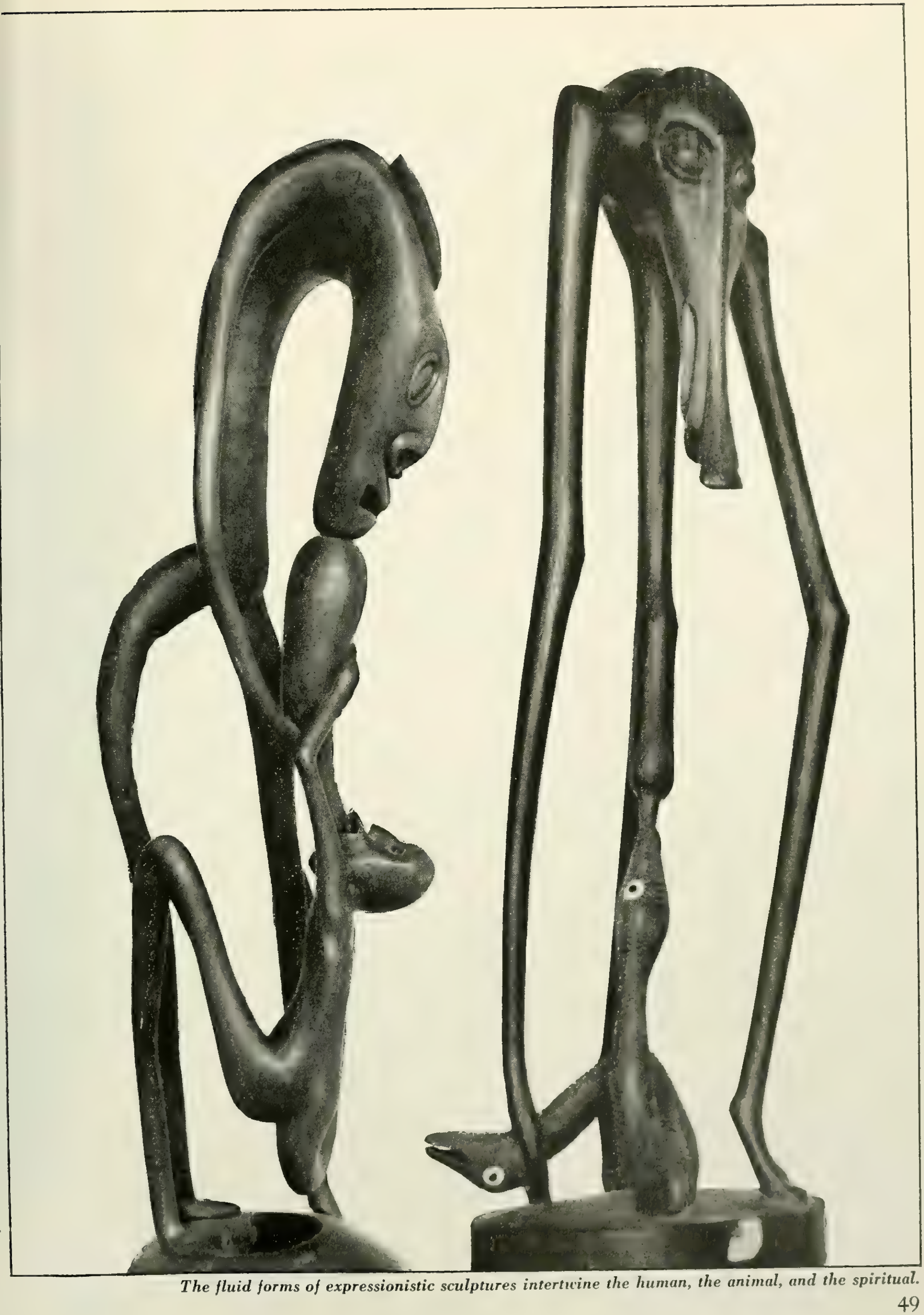


In Makonde life cycle, mother figure towers over old age, left, and child.

These feelings are expressed in Makonde sculpture through depictions of child murder, dismemberment, and torture.

It is possible in Makonde art to recognize the stylistic characteristics of individual artists. In the tradition of this art, a system of master-apprentice relationships was developed. Older, established artists taught talented youth, much in the way of the old master painters of the European world. Each artist can proudly refer by name to the master with whom he studied, and thus generations can be traced in the development of the art and of individual styles. A period of careful study enables one to recognize the work of such leading modern sculptors as Muar, Nangonga, Mtundu, Atesi, Briki, Andiki, Francesco, Samaki, and others. And there is, of course, excellent work by unknown artists still to be found in northern Mozambique, southern Tanzania, and even in the shops of Dar es Salaam. Some date back as far as the 1920's and 30's when commercialism on a fairly large scale first began. Some deal with life in the village and and the city, some with the Makonde spirit world, some with the armed struggle in Mozambique, and some are forceful and bitter commentaries on the church's conversion policies or its support of Portuguese colonial rule.

Although conditions constantly threaten to engulf him and destroy his art, the Makonde sculptor has struggled to maintain the continuity of his artistic heritage, to enlarge upon it, and to make it expressive of a changing society. The Makonde child can no longer be contained in traditional huts. Neither can the artist. He is Mozambican or Tanzanian. All the tribes belong to him and he to them. All the African landscape and animals are his own, and these are his new sources of inspiration. In the process of change, what was once tribal has grown into new and vigorous commentary on rural and urban East Africa. In the society in which he lives, his future will be determined by those who look upon the African heritage as a proud one, a heritage capable of bringing added enlightenment and a humanizing influence to this nuclear age.



The fluid forms of expressionistic sculptures intertwine the human, the animal, and the spiritual.

Minnesota harvests two-thirds of the world's wild rice. Once a dietary staple of the Great Lakes' Indians, the rice now graces the shelves of gourmet shops

WILD RICING

by Richard H. Hofstrand

French *voyageurs* and explorers chanced upon a new taste sensation when, in 1650, they first encountered the wild rice cultivated by the Indians of mid-America. They called it *folle avoine*, "wild oats." The Indians, who had been harvesting, processing, and eating wild rice for centuries, called it *manomin*, or "good berry."

In the northern lake country of what is now Minnesota, tribal wars flared for two and a half centuries over the bounty of wild rice, which supplied 25 percent of the Indians' caloric intake. Sioux and Chippewa (Ojibway) warriors fought each other for possession of the prized rice lakes and the valuable lands surrounding them. The Sioux were repeatedly driven from the woodlands of their native northern Minnesota, but after the Battle of Kathio in 1750, the Chippewas had undisputed claim over the territory—that is, until the white man finally drove them from these same lands and resettled them on nearby reservations.

Wild rice (*Zizania aquatica*) has grown in shallow water along the borders of North American lakes and rivers for thousands of years. It is a species of grass unrelated to ordinary cultivated rice (also a grass) and is confined to a small portion of the North American continent. About three million pounds of wild rice are harvested annually in Canada and the United States. Minnesota produces about 60 percent of the total. Another 35 percent comes from the Canadian provinces of Manitoba and Ontario, and Wisconsin produces 5 percent. These two states and two Canadian provinces are not

Two-man teams harvest Minnesota's wild rice. A skilled team may harvest 350 pounds of long-kerneled rice per day.

he only sections of North America where wild rice grows, but they are he only areas in which it flourishes. Actually, wild rice is indigenous to an area ranging from the southeastern corner of Manitoba, eastward to the Atlantic, and as far south as the Gulf Coast states.

In the fall the rice plants shed their grains, which drop to the lake bottom and lie dormant until late spring, when they germinate and sprout their first leaves. During the summer months the roots anchor the plant securely to the bottom, while leaves burst forth on the lake's surface and flowering stalks shoot upward. The fruits, or kernels, of the plant develop in late summer and are arranged in large clusters, called panicles, at the tops of the strawlike stalks.

Unlike cultivated grain cereals, which have been selectively bred for many years to improve their quality, the genetics of wild rice have not, as yet, been significantly altered by breeding techniques. Except for a few experimental rice stands in the Lake States region, all wild rice is of a "shattering" variety. This means that, unlike domestic grains, the kernels of rice on a particular panicle do not all ripen at the same time and do not adhere to the plant head once they mature. Wild rice begins ripening on a stalk from the top of the head downward. Only about 10 percent of the head ever matures at any one time. If not harvested, the ripened grains drop into the water and fall to the bottom.

Harvesting wild rice, except on commercial paddies, has changed little since the Indians reaped their

first kernels. The rice areas of Minnesota, totaling some 25,000 to 30,000 acres (mostly on publicly controlled lakes), are protected by state laws that insure that adequate rice remains to reseed the lakes and that wildlife can also share in the harvest. Ducks, geese, deer, muskrats, beavers, and blackbirds are particularly fond of the rice grains.

Wild rice harvesting on public waters in Minnesota is done from a canoe or other small boat. Measuring no more than 18 feet in length and 36 inches in width, ricing craft are propelled by hand (as opposed to mechanical propulsion), using long wooden or metal poles that will not damage the rice. These poles are either forked at the end or have metal "duckbills," which expand on a hinge when pressed against the lake bottom and contract when pulled back through the rice, thus protecting the stalks. Cedarwood flails (ricing sticks), which are approximately 30 inches long and about an inch in diameter and that weigh less than one pound, are used to gently tap the rice from the stalk.

A typical ricing vessel carries two passengers—a poler, who maneuvers the craft as he stands in either the bow or the stern, and a ricer. The ricer sits in the front, middle, or rear of the boat away from his partner. Holding a flail in each hand, he alternately works on either side of the boat, bending rice stalks over the edge with one flail and gently tapping ripened kernels into the bottom with the other. Indians are particularly adept at this method of harvesting. Few others are skilled enough to bring in good clean rice and often return with reeds, rice stalks, and broken, badly beaten rice kernels scattered throughout their boatload of rice.

The harvesters work all day (or for as many hours as the law will allow) during the three- to four-week season, which usually begins the last week of August. Seasons are set according to when most of the rice will be ripe. Hours and laws may differ from lake to lake and from county to county. Rest days are established between ricing days to allow the stalks to rise again where boats have run over them and to allow more grains to ripen. An entire rice bed may be harvested many times during a single season.

As boats and canoes are pulled onto the landings at the end of the day, ricers struggle to their feet after sitting cross-legged all day in the bottoms of their small boats. Before leaving the boat, they brush off the rice that still clings to their clothing so that none will be wasted. Every kernel means money to these people (there were 16,443 rice harvesters in Minnesota in 1968), most of whom are seasonally employed laborers who hold other jobs as iron miners, resort employees, lumberjacks, or marginal farmers.

Because rice hulls have a prickly "beard" on one end, which can cause discomfort or real pain when it comes into contact with a harvester's skin, ricers dress carefully, wearing tight-fitting clothing tied with twine at the ankles and wrists. Some use plastic raincoats, coveralls, or chambray shirts worn backwards.

After docking the boats, harvesters transfer the rice into cloth feed sacks. One member of the team stretches a flail across the bag's opening, while the other collects the rice from the boat bottom by double handfuls and dumps it into the sack. A flail or canoe paddle is used to pack the rice firmly into the bags and the sacks are then tied. When filled, each bag weighs from 50 to 80 pounds, depending on the quality of the rice and the amount of foreign matter present. Buyers come to the landings at day's end to bid on the rice. But if a better price is available elsewhere, the harvesters will load their sacks into their car trunks and head for the competitive buyer. Still other ricers will hold their goods a few days, speculating on a price increase. They can keep this green rice only a few days, however, because it is highly perishable. In order to prevent spoilage from overheating, it must be processed soon after harvesting. In plentiful seasons, a pound of green rice may bring only $.25, but in "short" years rice may go as high as $2.65. In 1969, the average price per pound was $.65.

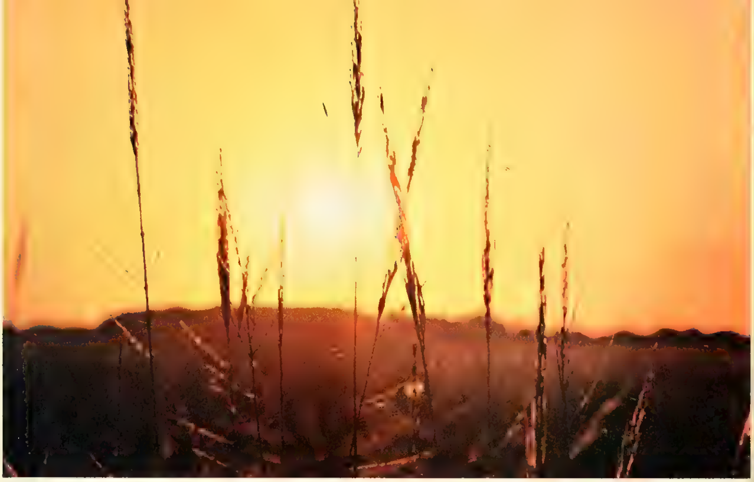
At Rice Lake, on the Rice Lake National Wildlife Refuge, ricing is regulated by the Fish and Wildlife Service of the U.S. Department of the Interior. Only Indians are allowed to rice on these former tribal lands. Wild rice at this particular lake is reputed to be of top quality both because the lake is reserved for the exclusive harvest by the local Chippewas, who are excellent ricers, and because the lake itself produces good rice. For these reasons, buyers congregate at Rice Lake each day of the special ten-day season to bid on the day's total pick of from four to ten tons.

Since Rice Lake is on a national wildlife refuge, the federal government has the option of taking 8 percent of each Indian's daily harvest for official use in seeding new lakes in Minnesota and other states. an arrangement that displeases some Indians.

On the opening day of the 1969 rice harvest, the highest-paying buyer ($1.18 per pound) drove away from Rice Lake's docks with nearly $12,000 worth of rice in the rear of his truck. The load would bring that particular buyer a three to four thousand dollar profit after it was processed and sold. In 1968, 1,309,300 pounds of native green rice, mostly grown on public lands, were harvested in Minnesota. But wild rice farmers have recently begun to add to the wild rice output. After years of experimentation cultivated wild rice, or "paddy rice," was successfully harvested in 1952.

A wild rice farmer begins his paddy by selecting a suitable, flat site accessible to much water. He clears the land, constructs eight-foot dikes around its perimeter, tills the soil to break apart clumps of loose sod, and in either the fall or the spring, he floods the completed paddy. Then he broadcasts the seed either from a boat or from a plane flying low over the paddy. Due to the high initial costs of land and development, wild rice farming is highly speculative. Paddies that produce a substantial crop one year may fail completely the next. Nevertheless, yields from paddies (about 300 pounds per acre) far exceed those from native stands (about 40 pounds). Farmers are hoping that the nonshattering strains now being grown experimentally will eventually increase their outputs to 2,000 or 3,000 pounds per acre. Presently, only a fraction of the rice on either native stands or domestic paddies is actually harvested; the remainder is lost due to inefficient harvesting methods. While this loss does insure reseeding in paddies and lakes, too much rice can result in overcrowded paddies that bring low yields the following year.

At present, the rice planted in paddies is mostly of the same wild variety that grows naturally in lakes and rivers. It grows in similar fashion, except that only about six inches



Since portions of a lake's wild rice crop ripen on different days, teams make successive visits to each harvest area.

of water cover paddy rice plants during the first three-quarters of the growing season. Native rice is covered by water varying from six inches to five feet, and the level remains relatively constant throughout the entire season.

As the rice crop approaches maturity in mid-July, farm paddies are drained to permit fields to dry. Then, by mid-August, 16-foot-wide harvesting combines on half-tracks are put to work to pick the rice. They comb through a field as many as four or five times. When all the stalks are finally bare, the paddies are tilled, flooded, and reseeded for the following year. Despite its riskiness, wild rice farming will probably produce most of the wild rice in North America by 1971.

Curing, parching, threshing, winnowing, polishing, and grading are the primary wild rice processing procedures. While modern technology has made many changes in primitive Indian methods, the basic procedures of finishing rice remain the same. The greatest amount of green wild rice is finished in small, individually operated plants, harvesters' cooperatives, or corporation plants.

Plants may process as much as 5,000 pounds of finished rice per day from more than twice that amount of green rice. Because the moisture content of green rice is relatively high, a weight loss of up to 60 percent occurs during the parching operation. An additional loss of 10 percent is attributable to unclean rice, which contains stalks, grit, and excess water. Occasionally, bags of rice purchased without inspection from unscrupulous harvesters have contained everything from mud turtles to water-soaked trench coats.

Curing, which is the initial step in the finishing process, takes about two days. The rice is spread outdoors on concrete slabs, and workers turn it continually so that it will dry. During the process, the rice changes its color

At day's end, harvesters beach their rice-laden canoes. The rice is inspected for quality, transferred to grain sacks, weighed, and sold to one of the buyers who wait on shore.

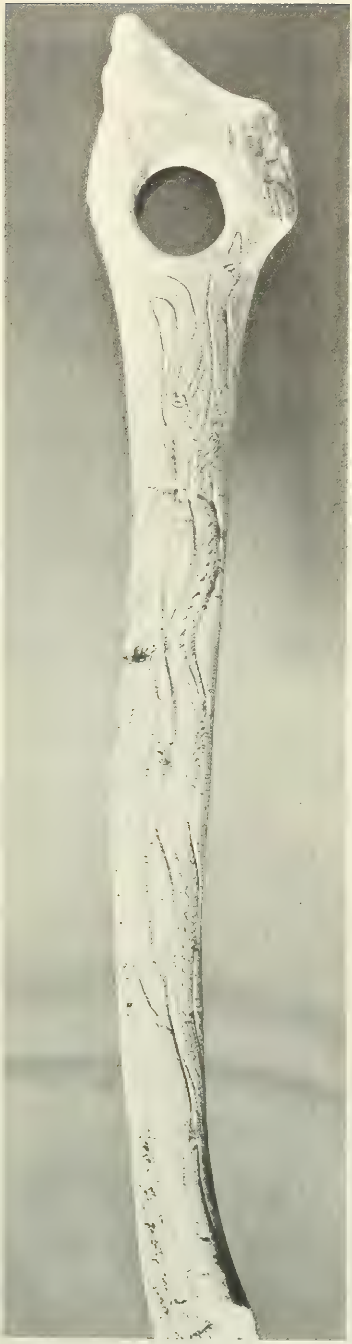
to a light brown. After two days of curing, the rice is shoveled into long metal parching drums that have slowly turning paddles. As the paddles tumble the rice, the hulls encasing the green kernels are roasted to a golden brown by the heat from the long columns of gas burners beneath the drums. Inside the hulls, the green kernels turn a rich black.

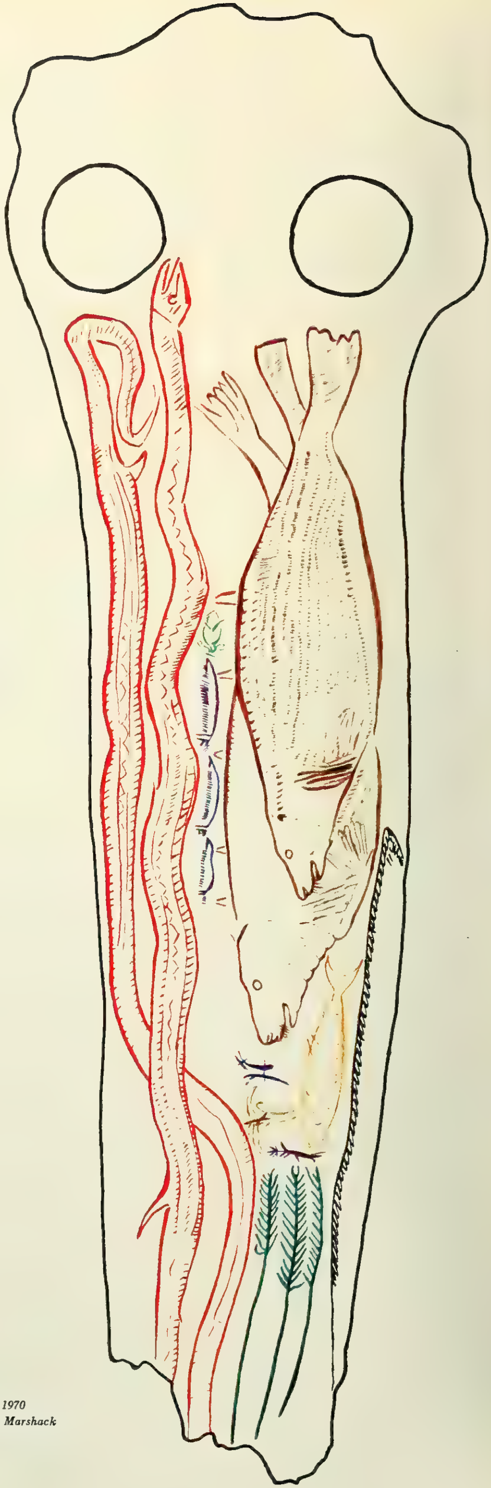
Parching takes from thirty to sixty minutes, depending on how damp the rice is. After it is dumped from the drums, the rice travels by conveyor to a screening machine, which removes all foreign matter larger than the rice itself, then moves on to the thresher, where the chaff is removed from the kernels.

After threshing, the freed grains of rice are tumbled against each other in a long tubular polisher. This removes a portion of the grains' heavy black coating, improving its appearance but lessening its nutritional value. Next, it proceeds to grading machines that use gravity and mechanical selection to sort the long from the short grains, the skinny from the fat, and the whole from the broken. Most plants separate rice into three primary grades. The small pieces are either ground into wild rice flour for bread and pancake mixes or sold as an economy grade of rice.

Bulk-finished rice is then sent directly to a distributor, sold to hotels or restaurants, or packaged for retail sale. Some rice is contracted to particular companies before the harvest actually takes place. Such distributors then package the rice under their own labels and ship it to retail markets. By the time it reaches the retailer, wild rice may take a number of different forms or may be included in several different products, including whole grain wild rice; instant, freeze-dried, or precooked wild rice; wild rice pancake, muffin, or bread mix; wild rice croutons; cream of wild rice soup; and wild rice with duck soup.

Today, wild rice and its derivative products generally fall under the classification of "gourmet items." If rice yields increase to levels predicted by its producers, this food may become a relatively common item in the American diet—although it can never be as common as it once was in the diets of those Americans who discovered this wild delicacy and perfected its harvesting.





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by Alexander Marshack

THE BATON OF MONTGAUDIER

Reindeer hunters living in France more than 12,000 years ago discriminated season, sex, and age when they engraved plants and animals on pieces of antler. Some images appear to have been subsequently crossed out, hinting at a sophisticated system of abstract representation at least 8,000 years older than what had been considered the oldest example, the picture writings of Mesopotamia and Egypt

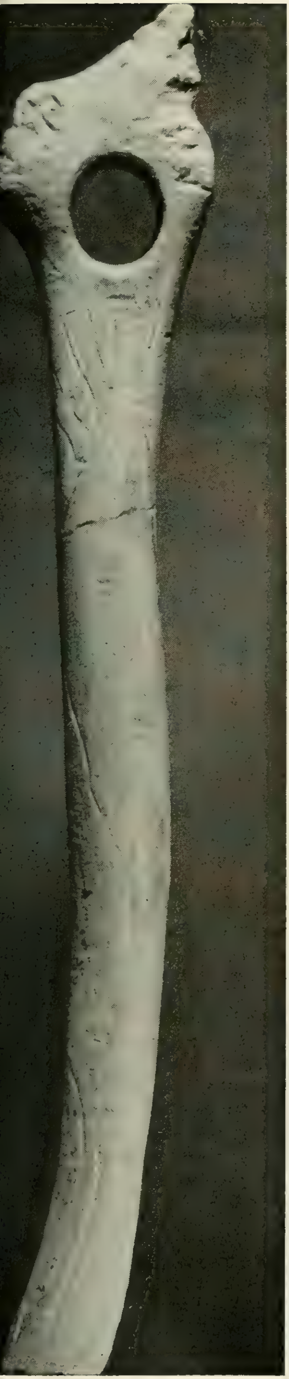
by Alexander Marshack

In 1885, a clublike staff of reindeer antler, about fourteen and a half inches long and with a hole at one end, was dug out of deep prehistoric layers of soil at the site of Montgaudier in the Charente hills of France. It was presumed to be a ritual staff of some sort and was therefore called a *bâton de commandement,* although no one knew what its precise use had been or why it had a hole. The baton was superbly engraved on both faces with many different kinds of animals. Because reindeer had been extinct in France for over 12,000 years, the baton had to be at least that old.

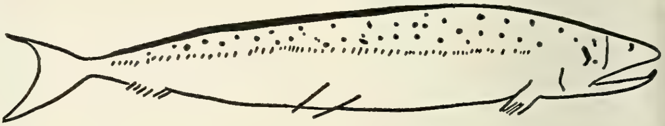
A note in the journal of the Anthropological Society of Paris in 1887 described it as "one of the most beautiful specimens of prehistoric art known." It would be at least 8,000 years before art of this quality—with its realism, fine line, delicacy of detail, and indication of perspective in the drawing of one animal behind the other—would appear again and then it would be found only in the highly developed agricultural civilizations. Yet this prehistoric engraving had been made by the rough hand of a "primitive" hunter with a stone knife.

Today we know that the baton was made by the late Magdalenians, the last of the reindeer hunters who lived in Ice Age France. It therefore represents both the peak and the end of an art tradition that began in Europe more than 35,000 years ago, when the first modern men walked into Europe carrying a new set of tools and a beginning skill in the first art of mankind. That skill continued and developed in Ice Age Europe for 20,000 years until the ice sheets began to melt and move north, the herds of horse, bison, reindeer, and mammoth that had roamed the tundra and valleys disappeared, and the hunter had to change his culture and way of life.

One hundred years ago, in the 1860's, the first examples of engraved art from the reindeer age were dug out of the ground in Europe and were recognized by archeologists as the product of men who had lived long before history and



Two faces of an Ice Age baton flank a drawing of the entire surface as it would appear if it were "unrolled."



Photographic enlargement and line drawing of engraved salmon reveal open mouth and hooked kipe in jaw, a sign that the fish was spawning.

had hunted animals long since extinct.

Although the first book on these ancient engraved artifacts was published in 1875, ten years before the baton was found, it was not until early in the twentieth century that archeologists acknowledged and accepted the fact that these reindeer hunters had also painted and engraved magnificent animal compositions on the limestone walls of caves in France and Spain. The most important of these caves, at Lascaux in France, was discovered in 1940.

The meaning of this extraordinary Ice Age art has been debated for a century. Theorists have proposed that the images were related to forms of primitive hunting magic or to sexual symbolism. But no one knew, for there was no technique for "decoding" or even properly analyzing the significance of this art.

The baton, for instance, posed a series of problems. The engraved composition contains two realistic seals. Obviously they were drawn on the basis of precise firsthand observation. Yet the Montgaudier site is about a hundred walking miles upriver and inland from the coast. During the Ice Age the coast of France lay many miles farther to the west, for a large percentage of the earth's water was locked up in the ice sheets that spread over much of Europe and North America, and as a result, the seas were far lower. Where had the reindeer hunter seen these seals? Why had he drawn them? Had the seals come more than a hundred miles upriver, or had the hunter gone down the river valleys toward the coasts? Was the reindeer hunter of France, like the modern Eskimo, a seasonal hunter of diverse species in different terrains? Had he hunted reindeer in one season and seal in another? We may never know, for any campsites that existed along the coasts are now deep under water. Besides, seals appear rarely in the reindeer hunters' art, and even reindeer images are infrequent when compared to the number of images of other animals—horse, bison, and mammoth.

In 1967, the baton of Montgaudier suddenly began to give us new information that placed the meaning of mankind's first art on a new plane and gave us important new clues to the intelligence and culture of this Ice Age hunter. The baton is rarely seen, either by archeologists or the public, for it lies under glass in a dim cabinet as the only engraved artifact from this period that is on exhibit at the French museum devoted primarily to animals and their evolution, the Musée d'Histoire Naturelle in Paris. Hundreds of better known examples of engraved Ice Age art are displayed in other French museums that specialize in the artistic works of man.

It is doubtful whether more than half a dozen archeologists have handled the baton or seen both engraved faces. It is known primarily through a line drawing of the compositions on both faces that was published in 1927 by the Abbé Henri Breuil, the Catholic churchman who is considered "the father of European prehistory."

In 1967, after cleaning the baton with alcohol to remove the heavy coat of protective wax with which it had been covered by the museum staff, I began examining it with a modern binocular zoom microscope. For three days I scanned it slowly, area by area, making micrographs as I proceeded. In the first hour I knew that the composition was significantly different from what had been previously seen or described. When the analysis was complete, the baton had become a new document. This was the first time the technique of microscopic examination had been used experimentally on these prehistoric engravings. The information revealed made it possible to reevaluate the cognitive capacities of early man. It placed the art of this hunter on a level with his tools as an important element of his culture.

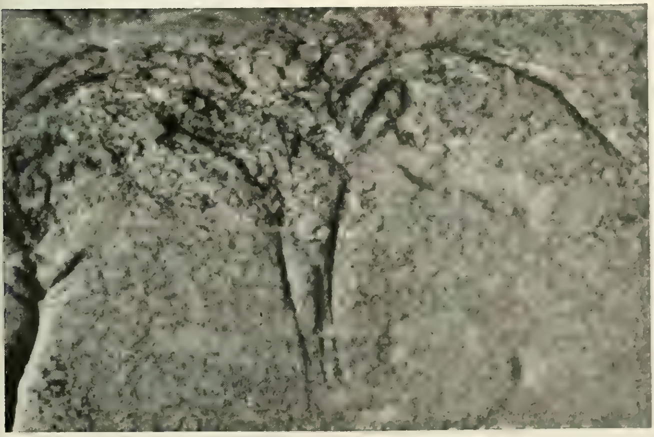
In the eighty years since the baton was discovered, archeology has grown up and matured. When the baton was excavated, the search for early man was in its infancy. Charles Darwin had published his revolutionary book *Descent of Man* in 1871, thrusting the search for the origins and evolution of man upon science. Yet when he wrote the book, Darwin had no knowledge of this prehistoric art, he knew of no early skeletons, and he was only vaguely aware of the existence of certain prehistoric stone tools. In the hundred years following his book, the discovery of these stone tools in the archeological layers helped form the opinion that the hominid who had evolved to become man was basically and primarily a toolmaker. Through his use of tools he had become supreme and had conquered the earth. As a result, the art of these early men was considered subsidiary. Archeologists, referring to his tools, call the period of the reindeer hunter the Upper Paleolithic, or Late Stone Age, but there is no term that recognizes that this was also the first age in which there appeared a complex human art and symbol. The new information revealed by the microscope hints that the development of this intellectual symbolizing skill was, perhaps, more important in the eventual development of civilization than were tools.

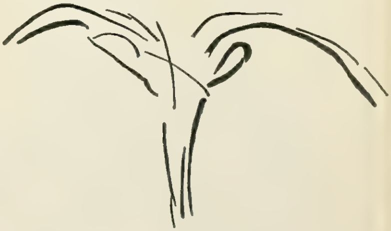
The first authors described the baton of Montgaudier as displaying two species of seals, a fish, two eels or snakes, one insect, and certain unknown creatures. The Abbé Breuil later reported that the fish was a mackerel with its mouth closed, and that the serpentine forms were a common variety of garden snake. Breuil, using only a magnifying glass, could make no sense of the innumerable minor figures he saw, which he therefore presented as unrecognizable blobs.

The microscope revealed at once that the fish is a salmon with its mouth open. The tiny engraved fish, about one and a half inches long, has the body markings of the salmon, the lower fins are in their proper places, and carefully engraved on the lower jaw is the hook, or "kipe," that the male salmon grows during the season of the species' migratory struggle upstream and subsequent spawning. Only the tail and the upper dorsal line are cramped and distorted, and the microscope showed that this is so because a sharp ledge drops off at this point and ends this face of the baton. Behind this edge is a break on the bone. The distortion had been forced upon the artist by the abruptness of the edge. This is not a generalized fish, or even a fish of a particular species, but a fish with differentiated sex and seasonal attributes. Rarely had specialists noted such detailed seasonal observation in Ice Age art.

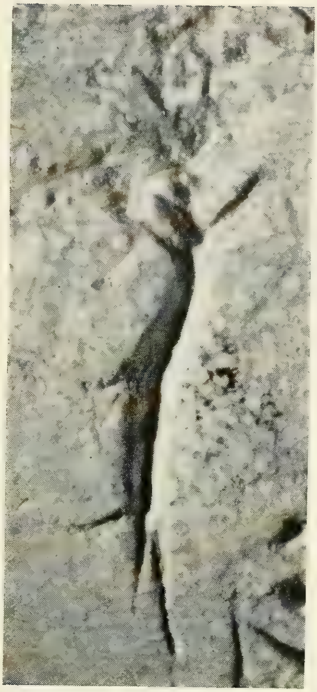
Near the mouth of the salmon are some of the uncertain forms noted by earlier prehistorians. They are so small, they were either disregarded or given the quickest of examinations. The microscope revealed that one of these forms is the perfectly realistic image of a spring sprout, including a careful engraving of the downward-pointing branched roots and the upward spreading leaves. The image is only half an inch high and looks as though it might have been engraved with the aid of a jeweler's magnifying glass. No such specialized plant image had ever been reported for the Ice Age.

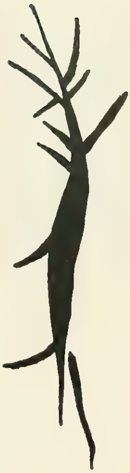
Near the sprout, above and to the right, lightly engraved and only one thirty-second of an inch larger, is a more complex image. The microscope revealed that it is the schematized head of an ibex, or mountain goat, with its two ears and two large, curved horns clearly indicated. The muzzle is a mere angle composed of four strokes. Exceedingly faint, but clear under the microscope, is an *X* across the brow of this abstract animal head, as though it had been intentionally and symbolically marked or crossed out after it had been made. This is a most unusual image—unrealistic and almost ap-





Ears and arced horns identify a schematized ibex. It appears to have been crossed out with an *X* across the brow, which may say something about a rite or ritual.





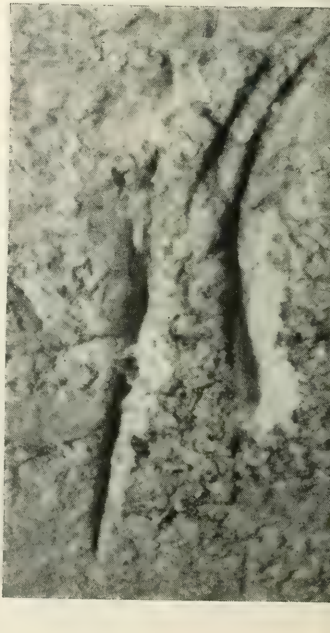
Detail never before associated with the Ice Age appears in the half-inch image of a young plant, complete with spreading leaves and roots reaching down into the ground.

proaching the stage of a sign or a symbol—that apparently served some purpose or use beyond that of mere art. The *X* seems to be indicating something about a rite or ritual. Now precisely this form of the schematized ibex head, seen front on, appears on other engraved pieces of the Magdalenian period, and usually it is a small, subsidiary image, part of a complex composition containing larger figures. These ibex images are also occasionally *X*'ed out. Had I stumbled on an example of a kind of symbol and notation that existed thousands of years before the first pictographic and hieroglyphic writing of Mesopotamia and Egypt?

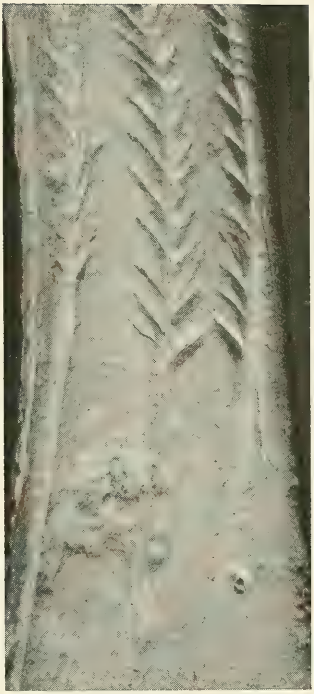
To the right of the ibex head there is a still smaller form, which at first seems unrecognizable. The microscope, however, can track all the intentionally made marks, and it showed that the form may be an extremely schematized, secondary "ibex head," indicated only by the strokes of the arced horns. The microscope also showed that this image was deliberately crossed out by two horizontal lines. Was this further proof that something symbolic was being notated and said? These three images near the salmon are so small they cannot be considered art or decorative motifs.

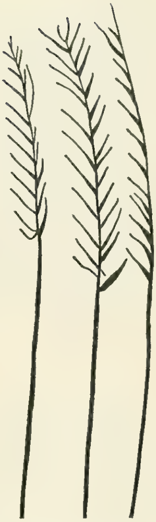
As the microscopic examination proceeded, the mystery deepened and the questions increased in number. To the left of the fish and the tiny images, near the bottom of the baton, are three forms of the type that, for half a century, were considered by French archeologists to represent barbed weapons, whether they appear in cave art or were engraved on smaller objects. They were presumed to be an indication of the so-called hunting magic that was apparently implied by Ice Age art. The microscope showed that these three forms are carefully drawn plants. The fluid, arced leaves are angled the wrong way to be effective as barbs at the point of a harpoon, while the linear structure of the leaves and the exceedingly long stalk are entirely different from the form of a possible feathered dart. There are engraved or painted harpoons and darts in Upper Paleolithic art (I have studied and written about them), but they have entirely different forms. These are plants, and analysis, over a six-year period, of a large proportion of Upper Paleolithic engraved art indicates that many of the so-called barbed weapons present in animal compositions (such as this one from Montgaudier) are, in fact, not weapons, but plants. Here was evidence that suddenly raised profound questions about the traditional concept of archeology concerning hunting magic, ideas that were once thought to explain many of the Ice Age compositions.

On the reverse face of the baton, below the intertwined serpentine images, is another series of forms. The Abbé Breuil could make no sense of these tiny engravings. In 1886 one of the forms had been called an "insect"; in Breuil's drawing it looks like a medallion or a shield. Under the microscope, how-

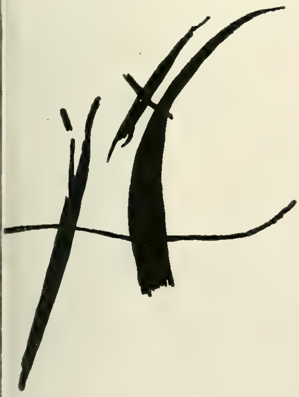


ever, the tiny form turned out to be a perfectly formed flower in full bloom. The engraving included the pedicel, sepal, leaves, and petals in what appear to be bud form.





These engravings near the bottom of the baton appear to be plants in full leaf. Previously identified as barbed weapons, they had given rise to speculation about Ice Age hunting magic.



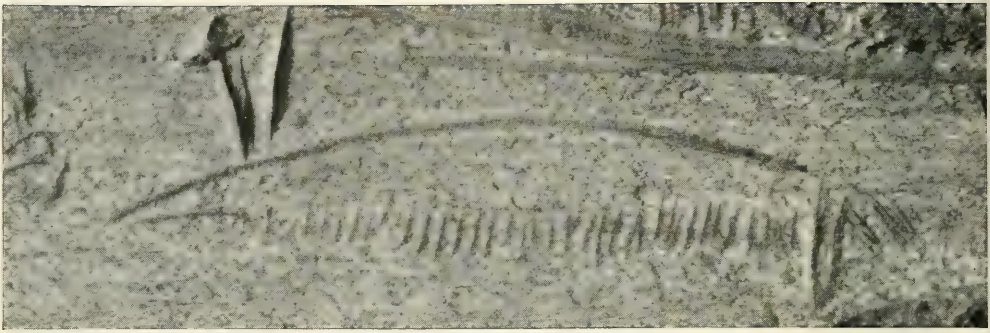
more schematized ibex head, bably too small to be nsidered art, also seems to ve been crossed out, this ne by two separate lines.

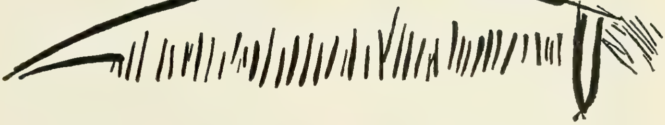
I had not even finished my microscopic examination, and yet, on a single object and in one composition, I had found that an Ice Age hunter had engraved three different aspects of plant life, each representing a separate stage of maturation. This was as startling as the hook on the jaw of the salmon. In almost a century of interpretation there had never been any discussion that touched on the possibility that this early hunter or his art was concerned with such extraordinarily precise details of his natural world and its seasonal processes. Almost all interpretations had been concerned with hunting magic or sexual symbolism. It is important to remember that the baton was engraved many thousands of years before true, formal agriculture began along the hillsides of Mesopotamia. Yet here was both a recognition and a recording, or symbolization, of vegetal differentiations and seasonal processes. Why had the hunter been interested? These tiny images were clearly not decorative. What was the artist trying to say or record? What meaning did these plants have in his life? What stories went with the images? Did the knowledge and lore implied in them have anything to do with the general cultural preparation for the development of agriculture that would come later?

To the left of the flower are three odd creatures, each containing the same details. Each has an arced "back," a pointed, stubby "tail" or "head" at the left, and a series of tiny centipedelike feet (or a ciliated fringe) along the bottom. At right, each has an appended "foot," and each ends with strokes that form a kind of "beard." The appearance is that of a sluglike creature of low or damp ground or the water bottom. Since the three forms have the same basic details, they clearly represent a species. With all the intentionally engraved lines now documented, it should not be difficult for the zoologist or naturalist to attempt an identification of the odd creature.

There is one final group of minor images, six tiny angles deeply cut in a linear series between the two faces *(page 62)*. Like the *X* engraved on the head of the ibex, these are not realistic images. Nor are they particularly decorative. Instead, like the *X*, they seem to be abstracted marks with some symbolic meaning. These angles raise a different set of questions concerning Ice Age symbolism and are part of another, more difficult study.

We can now turn our microscope on the major images, the two seals and the two serpentine forms. Examination of the seals revealed that the engraver had differentiated, with care, not two species as was thought earlier, but a bull seal with its large and heavy muzzle and a smaller,





Sluglike creature has many feet or cilia, a pointed head or tail at left, and a large "foot" and a "beard" at right. Above the animal is one of six deep-cut abstract angles.

more delicate seal, probably a female, although it could be a young animal. In either case, we again have "seasonal" images, because the dominant bulls collect their harems of females and mate in a limited season during the summer, and the young, too, are born and begin to swim in particular seasons.

The serpentine images on the baton were at first called eels, but the Abbé Breuil said that the geometric pattern of their markings and the presence of the pointed phallus suggest that they are nonpoisonous, common grass snakes of the family Colubridae, snakes that "reappear" in the springtime and can be seen swimming in the flooded streams. The microscope showed that one of the snakes has an open mouth.

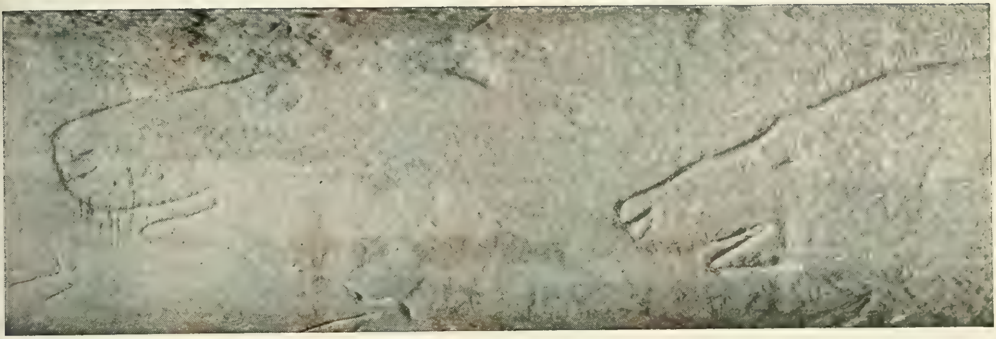
What we have, then, is a composition in which diverse species from separate realms (ocean, river, ground, and mountain) are differentiated according to their season of appearance, sex, and stage of maturation. All the images are of the spring and summer. We can conjecture that the precision of rendition had a complementary vocabulary for naming and identification, and that it probably also included a lore with which the hunter explained the seasonal reappearance of the species involved and probably the general rebirth of spring and summer.

If the Ice Age hunter had such highly developed skills of observation and recognition in the diverse realms of his environment, with a presumed lore and mythology to go with them, what happened when the ice melted and his environment changed? Was he then able to use these intellectual skills, of which he has given us evidence, as well as his knowledge of seasonal periodicities, in the transition toward agriculture or specialized fishing? To what extent did symbol making, that is, "art," as well as ritual and ceremony make it possible for him to retain this basic lore and knowledge of the seasons even as the species around him changed?

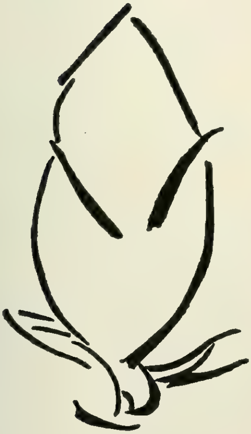
How much more will the microscope tell us about the range and quality of this early hunter's thoughts? Hundreds of engraved compositions now lie in Europe's museums and thousands of engraved and painted images are still on the walls of the sanctuary caves. Can we eventually break the code of such mysterious symbols as the cross and the angle and learn the meaning of a vast range of other symbols that this early man has left us? Can we learn the meaning of the sequence of his engraving, for obviously the large animals on the baton were engraved first and the smaller images later?

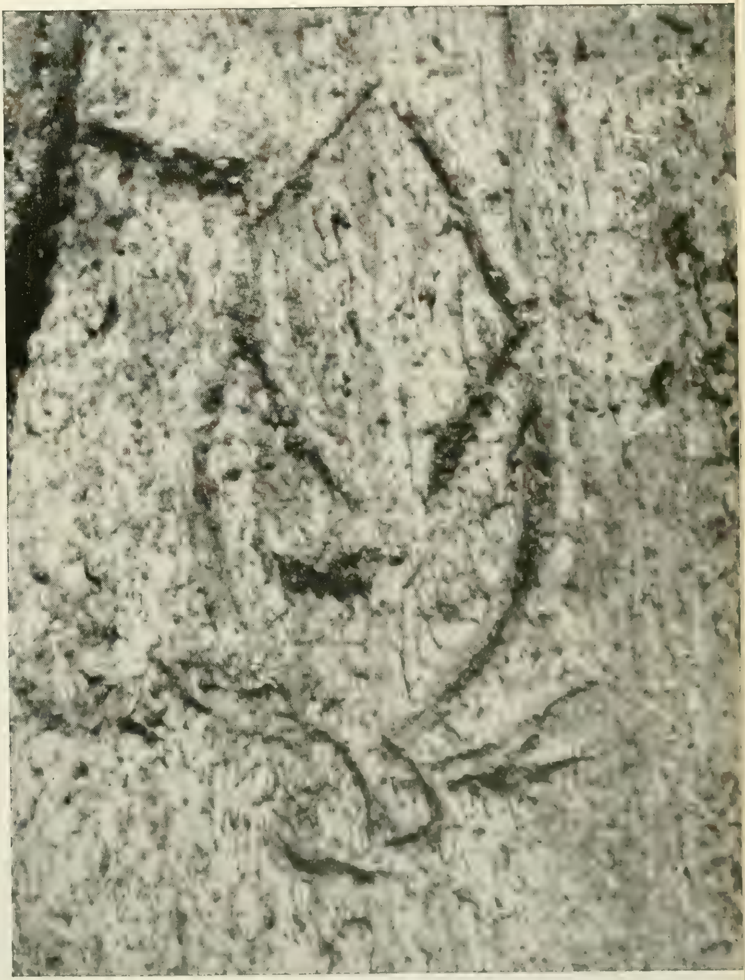
Is it possible to determine the meaning of the schematized ibex heads? Can we find any clues to rituals held in the spring and summer that may have involved the sacrifice of the ibex? Can analyses of complex engraved compositions, such as those on the baton, give us clues to the meaning of the compositions in the caves? Can microscopic analysis of the holes tell us for what purpose the batons were used?

The questions are endless. But the evidence indicates that this man was thinking and doing, observing and saying something far beyond what we have given him credit for. This man was our first true ancestor. He is the first fully modern man, and his art and symbols may tell us more than his tools ever did.



The two seals appear to be a bull and either a female or a young. A flaw in the bone near the smaller seal's eye led early researchers to call it a different species.





For years, six tiny images like this one defied description. Under the microscope they appear to be flowers in bloom—complete with pedicel, sepal, leaves, and petals.

THE GULLS OF WALNEY ISLAND

by Barbara R. and Michael H. MacRoberts

The South Walney Nature Reserve, on Walney Island off the northwest coast of England, is a montage of terns plunge diving in the shadow of rusting machinery, of March gales, of mussel beds on the edge of the low-tide beach, and of jackdaws nesting inside Piel Castle. The cranes and docks of Britain's industrial north loom above the island's mudflats in juxtaposition with the crag of Black Combe in the distance and the green fells of the lake country across Morecambe Bay. Gravel trucks bump along the road from the island's south end, past the sand dunes and marram grass to the cities and towns of Cumberland and Lancashire. The mounds of earth and pebbles thrown up by the gravel excavations gradually cover-in meadow buttercups, and later ragwort and thistle.

The changing colors of the island's landscape through the short time of the breeding season are the expression of a wide variety of wild flowers and grasses: oyster plant and sea holly, yellow agrimony and fox-and-cubs, horned poppy and henbane, and the flowers of the fells such as harebell, heath, and gorse. The bracken, a glowing brown in winter, grows green and velvet in summer.

Walney Island, a seabird breeding area from time immemorial, is one of the more spectacular gull colonies in Europe—with some 70,000 herring and lesser black-backed gulls nesting on the 230 acres of the nature reserve at the south end of the island.

The area is rich in food not only from the marine fauna of the tidal banks of Morecambe Bay and the beaches of the Irish Sea but also from the refuse of industrial towns, like Barrow-in-Furness across the channel from the reserve, the fishing harbor of Fleetwood, and the garbage dumps of Millom.

In the middle of the last century, the town of Barrow began to expand, and man's encroachment into their breeding areas on the north end of the island threatened to force the birds out, but today Walney's gulls are protected and have re-established themselves on the southern end of the island. The old depredations of egg collecting and human interference are rare. Predators of the past, like fox and stoat seldom visit the colony, and hawks no longer cast a hunting eye over the gullery.

Because of their great numbers, the gulls are the most striking inhabitants of the Walney Reserve, but many other seabirds, waders, and fieldbirds are found on the island's south end. Oystercatchers and ringed plover nest along the high-tide line and in winter feed here in great numbers. A pair of mute swans return every year to raise their four to six gray young along the banks of green-scummed ponds. Lapwings nest on the reserve as do skylarks, clutches tucked away in the grass; reed buntings and the snipes and meadow pipits nest in the pasture and heath; and stonechats and swallows, in the crevices of gun emplacements left derelict from the war.

On summer days the harsh voices of greater black-backed gulls give the air a grumbling undertone. Terns, which nested in the main reserve forty years ago, are confined today to the spit in front of the lighthouse. This small pebbled peninsula appears quite bare of nests at first glance, but after careful searching, the tiny cryptic eggs of little tern suddenly appear and the downy chicks of arctic, common and Sandwich terns jump into focus against the mottled background.

Shelduck nest in holes in the banks of hills and dunes, and mallard startle from the brackish pools and reeds of the salt marsh. These ducks have great difficulty in raising their young on the gravel ponds in the middle of the gullery. The parent birds' defenses are inadequate to cope with aerial predators in such numbers; as the gulls hover above, the ducklings scatter and dive, only to be picked off one by one as they surface.

Unlike the shelduck and mallard, the eiders have been very successful on the reserve, and over the past twenty years their numbers have increased. The defense of the female eider differs radically from that of the other ducks; she remains in the water and furiously stands off the swooping gulls; her young, instead of scattering, cluster around her at the first sign of attack. Even on the ponds where most shelduck and mallard young fall prey to the gulls, the eiders successfully raise their ducklings. Eiders begin to come ashore at the end of March, and early spring sees the water bright with drakes. By July the sea and bay are dotted with brown females and their young, and long files of hardy black ducklings, trailing behind their mothers and often surrounded by other eider "aunties," march down to the water a few hours after hatching. By Au-

**ulls return to Walney after
oraging at Barrow-in-Furness.
isible in the background
re the cranes and docks of
ritain's industrial north.**

gust, nearly all the ducks have gone to sea with their young, the drakes having left earlier to molt. One awaits the next season with especial anticipation of the beaches covered with these elegant birds.

It is, however, the return of the gulls in early spring that signals the beginning of a new cycle. During February, March, and April the lesser black-backs return from their winter quarters in Spain and North Africa. Those herring gulls that have spent the winter scattered over northwestern Europe begin to congregate in and around the reserve in early February, swelling the ranks of herring gulls that overwinter on Walney itself. At first the birds spend only part of the day in the colony where they will later establish territories, and even as late as mid-March the colony may be deserted at night when the birds leave for the open beaches, a safer habitat during dark hours.

The beginning of the breeding season is a time of settling and unrest. Most individuals remain attached to the same mate from year to year and set up territories on, or close to, the area where they nested the previous spring; but birds returning to their old nest sites often find their ownership contested by unmated males, many of which are breeding for the first time. In a welter of calling and posturing, the males fight to establish territorial rights. Females take a less active part in these early territorial disputes, which, more often than not are bluffs rather than battles, although later in the season when they have paired, the females will defend their homesites with equal vigor.

Since these gulls generally are monogamous, the many widowed or unmated birds are faced with the problem of finding mates. Lone females survey the colony from the air and land on territories of single males. They approach hesitantly and come within several feet of the male, their "mixed feelings" apparent in their elongated necks and nervous back and forth approach. The male alternates between accepting this strange bird as a desirable mate and greeting her as an intruder on his hard-won territory. If, in response to his gestures, she comes close, he may suddenly pull and peck at her and drag her about by one wing. This period of mutual distrust and attraction, so evident from the postures of the birds, gradually wanes and ambivalence is eventually replaced by the solidity of the pair bond. As territorial boundaries are settled and pairs form, the colony becomes quiet. By late March and early April territorial sparring and mate-hunting females are infrequent sights.

The herring gulls favor the easternmost part of the reserve, and they establish their territories on the turf- and marram-covered hills or on the sand dunes common to this part of the gullery. The lesser black-backs favor the western sections of the colony, nesting in the bracken and grass valleys and on hummocks. However, much overlap occurs, and in mixed areas a quick perusal of nest locations shows that the herring gulls build their more elaborate nests predominantly on high elevations, and the lesser black-backed gulls build their simpler, turf-lined scrapes in valley bottoms and on gentler slopes.

By early April, the colony is a patchwork of mated pairs busy with nest building. During the time before the eggs are laid, a male feeds his female a few times a day on half-digested food that he regurgitates at her begging request. Mating takes place several times daily, but ceases abruptly as does "courtship feeding" when the egg laying begins in the third week of April. The usual clutch is three blotched brown-and-green eggs, and although the majority of herring gulls lay earlier than the lesser black-backs, there is considerable overlap of laying dates. In each species the parents incubate in turn and keep a sharp eye out for egg-robbing neighbors. The brooding birds are difficult to drive off the nest, but when annoyed they dive at intruders, hit out with bill and feet, and scream insistently.

Thirty days after the eggs are laid, the chicks begin to hatch and the tempo in the gullery quickens. Not long out of the shell, wet and helpless, the chicks quickly metamorphose into animated down and scurry into the grass and bracken. With heads hidden and tails exposed, they crouch at the first sign of disturbance. The parents are kept busy guarding their fast-growing offspring and the many badly pecked corpses of chicks attest to the need for watchful parental eyes. Neighboring gulls are serious predators on both eggs and young. The adults are busy, too, with feeding runs to the rubbish dump and shorelines, although food is apparently so abundant on Walney that the chicks do little begging. It is not unusual to see parents reswallow food ignored by already gorged young.

By late July and August the speckled chicks have grown into sleek, mottled brown birds, now as large as the adults and flying well. The birds gradually become restless in the colony and panic easily; great clouds of gulls shoot up from the dunes and valleys at the slightest disturbance. The adults spend more time outside the breeding grounds on the beaches and mudflats, and large, loafing groups of juveniles cluster near the shore. The days become more and more empty of gulls. By late September the colony is a litter of food debris and molted feathers; the gulls are gone, leaving a scatter

ragged nests and dying bracken. ls the cycle draws to a close, the ıer black-backs migrate to the lit- al of Spain and North Africa, al- ugh in recent decades some of ir number have begun to over- ıter in northern Europe. The her- g gulls disperse into areas close to ir summer residence, but many ·rwinter in and near the camp.

Over the last fifty years there has ·n a spectacular increase in the rth Atlantic gull populations, and lay hundreds of colonies dot the ıtern and western Atlantic sea- ards. Symptomatic of this increase numbers has been the extension the breeding range of both species. e lesser black-back, which does t breed in North America, has now en reported as far west as New- ındland in winter. Why the gulls ɘ becoming so numerous is an in- ·esting question, and by pooling ɘ data of many observers it may be ssible to piece together an answer.

From the meager beginning of a ıv pairs in the 1920's, the Walney ıpulation has grown to about 35,- ı0 pairs, doubling in number in the ɜt four years alone. Initially the lony spread at its periphery when gulls acquisitioned new land for breeding sites. Later the density increased, and between 1965 and 1969 the population doubled primarily by an increase in density, although some expansion occurred. In these four years, the size of territories decreased from approximately 40 square yards per nesting pair to 25 square yards. In some areas of the gullery, the density is much higher.

Although the initial settlement of a colony must, of course, involve immigrant birds, further expansion of colonies like Walney is due to the tendency of young birds to return to nest in the colony of their origin. This gives us some idea of the approximate survival rate of birds.

Food and predators are important factors in containing the numbers of animals, and it is probable that the gulls on both sides of the Atlantic are living today under conditions somewhat different from those under which they evolved in the past. Their breeding areas along the Atlantic coasts have brought them into increasing contact with an expanding human population, which has affected the environment in ways that may give clues to understanding the

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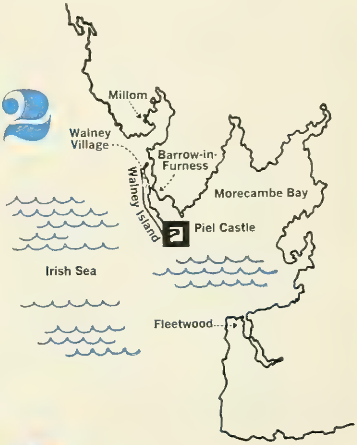

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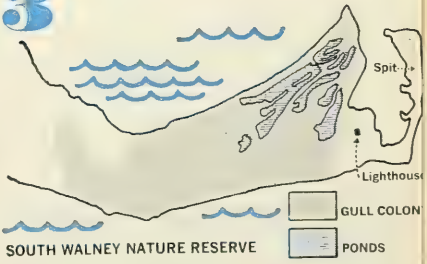


Herring and black-backed gulls swarm over the Walney dump, where more than 15,000 tons of human refuse are deposited each year. Since 1945 there has been less ash and more foodstuff in the refuse, and many more gulls feed on it.

tremendous increase in gull numbers. Human activity in many areas has contributed to the extinction or decrease of animals such as the fox, stoat, weasel, eagle, and hawk, which have been predators on the gulls. In Britain, these once important predators are rare or absent in many localities, and on Walney there are no important predators of this sort today and it is likely that there have not been for some time. However, elsewhere foxes still predate gulls, and this may contribute to the low gull populations in those areas.

Man's protection of these and other seabirds further reduces natural losses. Today many gull colonies like Walney are relatively free not only from such predators as the fox but also from the depredations of egg collecting and the killing of young birds for food by the human inhabitants. For example, in the late nineteenth century, herring gulls were uncommon in New England where today they number in the hundred thousands; men took the eggs and young for food and the skins for the plumage trade. In Britain, Lundy Island and Bardsey off the Welsh coast still suffer from egg collection, and this may be one reason that their gull populations have not increased at the same rate as other, protected colonies.

Just as important, man has also created a situation of potential food abundance. His dumping of exposed garbage, his fishing industries, and his slaughterhouses are food sources for scavenging gulls. Sewage outlets run into many feeding grounds of the gulls. The affluent society of western Europe and North America, which throws away so much, has led to an increase in edible refuse.

For Walney's gulls, the food supply is large. The flight distance is about one hour each way to the rubbish at Fleetwood and Millom. The rubbish dump on the island itself, where all the refuse from Barrow and Walney is dumped—some 15,000 to 19,000 tons a year—is about two miles from the gullery. Due to a better standard of living since the war, householders throw away more foodstuffs. With the use of new forms of fuel, there has been a decrease in the ash content of household refuse, which may have previously impeded the gulls' effective exploitation of these sources. All the Barrow garbage dumps have been within an eight-mile radius of the colony, and there has been a large increase in the number of gulls feeding on them over the past several years.

Although both are marine aquatic birds, the herring gull is more coast-bound than the lesser black-back; it scavenges from fishing vessels, garbage scows, and dumps and also shore feeds on intertidal fauna. Inland it occasionally follows the farmer's plow in search of worms and insects turned up. The lesser black-back, although not avoiding shoreline feeding, has traditionally been a fisherman in waters of the continental shelf, in estuaries and sometimes inland. but more recently it too has begun to exploit human refuse. Feeding habits in these two species overlap considerably, perhaps more so in the last several decades. At Walney both herring and lesser black-backs can be seen patrolling the shoreline and intertidal area for fish and marine invertebrates and for edible debris washed up on the beaches. Food remains around the nests attest to a widespread use of the refuse dumps; butter wrappers and chicken bones usually outnumber the remains of natural food items.

Information on glaucous-winged gulls on the North Pacific coast, on herring gulls in New England and Canada, and on other gulls elsewhere in Europe also suggest that food abundance is an important factor in population increases. Researchers of the Massachusetts Audubon Society have observed that along the coasts of New England, Nova Scotia, and Newfoundland the largest and densest gulleries are near sources of human refuse. Islands at some distance from such sources are sparsely settled even though the habitat does not differ from sites near centers of human population.

In the Netherlands, the gulls have increased despite attempts to control their numbers. During the war control measures were not taken; yet, due to the general food shortage for the human population, the gulls decreased. After the war, when food was again abundant, the gulls began to increase, although measures to control bird numbers were reinstated.

Dispersal figures for young and adult gulls show that not only during the breeding season, but also during the winter months, gulls concentrate in large numbers in areas such as harbors, large cities, and big coastal ports. Refuse may be important for the survival of adult birds during times of winter stress and may be especially important for juveniles in their first year of independence. In New England, when chicks first leave the colony at the end of the breeding season, they congregate in large numbers at sewer outlets, fish factories, and near fishing boats, pig farms, and dumps. Winter surveys of gulls from Mexico to Canada have shown a disproportionately larger number of young birds at dumps than at natural feeding areas.

Although the natural foods of the gulls (fish, intertidal fauna) have not increased drastically, the human refuse on Walney and elsewhere apparently can support a very large number of birds. What the potential gull population may be, we do not know.

One can conclude, then, that the factors of decreased predation, protection, and increased food availability—all related to man's behavior—are the bases of the burgeoning gull numbers. All these factors are important at the Walney colony, which is a dramatic example of a population explosion. It would not be surprising to see 100,000 gulls breeding on the reserve in the next few years, and for some time to come, Walney likely will remain the astounding place it is today.

Cattle graze among th
evenly spaced gulls in part o
the South Walney Natur
Reserve. Some 70,000 gull
nest in the 230-acre reserve

SKY REPORTER

A QUESTION OF PRIORITIES A panel of leading U. S. astronomers has published a $250-million-a-year wish list of what they would like done in space during the 1970's. They have already been told not to hope for even half of what they asked.

Excited by the startling discoveries of the last ten years, astronomers are eager to push farther into space along the new avenues opened to them at gamma-ray, X-ray, ultraviolet, and infrared wavelengths. All are usable only above the earth's atmosphere, and satellites offer months and years of observations in place of the present rocket and balloon measurements lasting only minutes or hours. Even without more money, space astronomers could easily get ahead of themselves. Compared with the total space budget (currently "reduced" to $4 billion), the $125 million apparently left for space astronomy is modest, if not austere. But compared with the capital budget for ground-based optical astronomy, it represents unimaginable riches. And without adequate ground-based support, space astronomy could find itself operating in a vacuum it never intended.

The 200-inch Palomar telescope has been unique since it was completed in 1949, able to see farther out into the universe and further back in time than any other telescope. Only the most promising observational programs are accepted for it, and then the researcher may have to wait as long as fourteen months for his turn. Yet to build another Palomar even at today's prices, would cost only $25 million. Spread over five years, this figure is a small fraction of even the current NASA budget for astronomy.

Many astronomers were publicly bitter when the first Orbiting Astronomical Observatory failed to operate after launch in April, 1966. Horace W. Babcock, director of the Mount Wilson and Palomar Observatories, pointed out in *Science* that the $62 million spent on the satellite could have paid for three more Palomar telescopes (including site development and smaller supporting instruments) at then prevailing prices.

Two 150-inch telescopes, one in Arizona and one in Chile, have been started by U. S. agencies since then, but they will not meet even existing demand. And space astronomy project will create new demand. Whenever a new object is discovered at some exotic wavelength, further study at the traditional wavelengths usually provides most of the information—as happened with quasars and is happening now with X-ray sources. The ground-based telescope must be large, because the new objects are, almost invariably, optically faint. Without accessible, large optical telescopes, discoveries made in space would remain only tantalizing hints of knowledge yet to be gained. The same sort of argument has been used against the current schedule of frequent Apollo trips to the moon—many feel we should not make a new trip for more information until we have had time to digest the information from the last one and can plan the next one accordingly.

The space astronomy panel calculated that just the four astronomy satellites already funded, if they work as long as expected, will require 2.5 years of observations on both of two new 200-inch telescopes to complete the picture of the ultraviolet and X-ray objects being studied.

Perhaps the most important items on the panel's wish list are, not the orbiting optical and radio telescopes, the gamma- and X-ray detectors, and the improved Explorer spacecraft, but the new Palomars on earth, which the panel feels are essential if space astronomy is to reach its potential.

INFRARED GALAXIES The betting now seems to be that all galaxies have extremely bright infrared sources in their nuclei. In our own galaxy, a small portion about a light-year across radiates in the infrared with a power some 100 million times that of the sun. And ours is the weakest of the dozen or so galaxies measured so far.

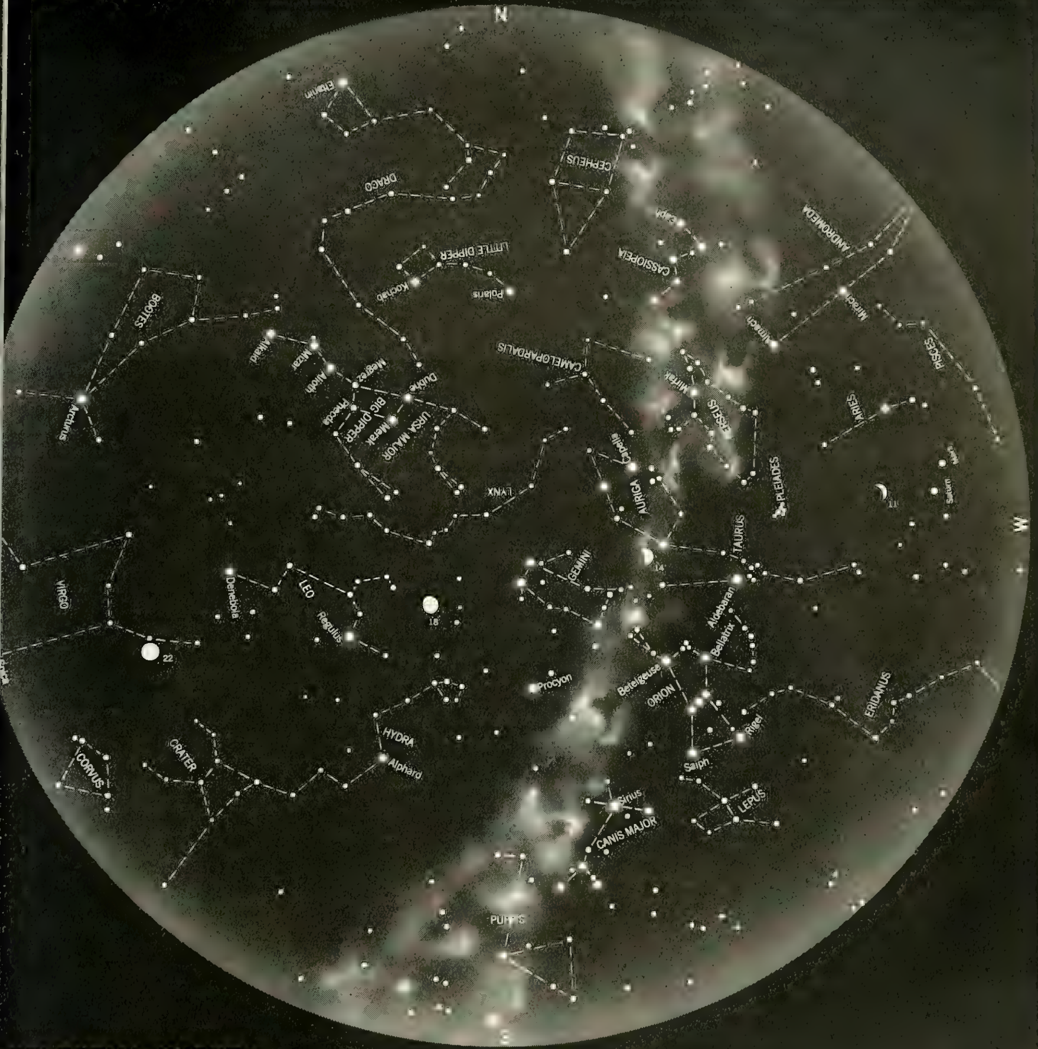
The infrared portion of the spectrum lies between visible light and microwaves, the most energetic of the radio waves. Most infrared radiation cannot penetrate the earth's atmosphere; it can be observed and measured only when the instruments are above as much of the atmosphere as possible—50,000 feet is standard.

The first galactic infrared "excess" was recognized only in 1964: the quasar 3C 273 was found to be radiating more power in the infrared than at all other wavelengths. Astrophysicists wanted to know why this tremendous amount of energy was being released, and why it was being released in the infrared. A pioneer in infrared astronomy, Frank J. Low of the University of Arizona recently offered one solution at the Boston meeting of the American Association for the Advancement of Science.

Low suggested that just this sort of radiation should be dominant if matter and antimatter were forming and then annihilating within small "cells" inside galactic nuclei. Resultant high-energy particles would radiate in the infrared as they moved at relativistic speeds through a magnetic field. Newly created mass would not be radiated away, but would accumulate in the nucleus until ejected.

If this much is true (and galactic ejection of mass is almost certainly going on), then Low proposes that we can measure the age of a galaxy by the proportion of its radiation emitted in the infrared. The youngest protogalaxies, or quasars, emit the most infrared, followed by galaxies that still have optically bright nuclei, then older but still unstable galaxies, and finally, mature galaxies like our own, in which most of the mass is in the form of stars.

Using the suffix *tron*, commonly used for man-made particle accelerators, Low calls his galactic cells "irtrons"—the initial *ir* standing for infrared. Do they really exist? Low thinks study of the outbursts almost continually observed in the brightest infrared galaxies could supply an answer. JOHN P. WILEY, JR.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Alioth
Megrez
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Merak
URSA MAJOR
CAMELOPARDALIS
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TAURUS
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GEMINI
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LEO
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Regulus
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Aldebaran
Bellatrix
Betelgeuse
ORION
Procyon
ERIDANUS
HYDRA
Rigel
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CRATER
CORVUS
Saiph
Sirius
LEPUS
CANIS MAJOR
PUPPIS
S

CELESTIAL EVENTS

The moon is in the morning sky until new moon on March 7. It then enters the evening sky, with first-quarter on the 14th and full moon on the 22nd. Thereafter, it is a morning moon again, with last-quarter on the 30th.

Venus, Mars, and Saturn are evening stars. Venus may be seen low in the west after sunset toward month's end; Mars and Saturn are higher than Venus, in the west, and set later. Jupiter, in Libra, rises in the east shortly after dusk and remains visible until dawn. Mercury is too close to the sun to be observed.

March 7: Total solar eclipse visible in Mexico, southeastern U.S., and eastern Canada. Eclipse will be partial over rest of U.S., except western Alaska (*see* NATURAL HISTORY, February, page 26).

March 10-11: Mars and Saturn are to the left of the crescent moon on the 10th, to the right and below on the 11th. Saturn is the brighter planet.

March 16-17: Mars and Saturn appear very close on these evenings; Mars the uppermost, Saturn the brighter. Conjunction of the planets occurs at 3:00 A.M., EST, on the 17th.

March 19-20: Regulus is the bright star to the left of the moon on the 19th, to the right on the 20th.

March 20: The sun arrives at the vernal equinox at 7:57 P.M., EST, and spring commences in the Northern Hemisphere.

March 23: Mercury is in superior conjunction and enters the evening sky.

THOMAS D. NICHOLSON

★Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 9:25 P.M. on March 1; 8:30 P.M. on the 15th; and 7:25 P.M. on the 31st; but it may be used for about an hour before and after those times.

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The Day the Sea Ran Out of Flounder

Continued from page 31

"Don't use a shovel," he called over to me. "The warden'll pick you up for sure."

"When I was growing up, we used to go everywhere. Not just along the shore, but all over the fields and woods too. You could go anywhere. Now it's all posted or blocked off. Well, it's their property, they can do what they want. Some years ago the town could have bought the point, but the price was too high. Of course, it's worth quite a bit more now with lots and houses and all.

"We used to go swimming down off the point. Oh, I don't know, we've got a beach and it will do us for now. Land down along the shore is too expensive, way out of line. I can remember when you could get all you wanted for almost nothing. Well, nobody wanted it then. No, I don't think the town needs more land. The way prices are it will raise taxes. What'll they use it for anyway? I sold some shore property. If I'd held, I could have made more money, but I got enough out of it. I still stroll around some. I'm getting too old to cut across lots, so I stick pretty much to the roads anyway."

Ruth Billard is a charming, soft-spoken young woman who is a wildlife biologist for the Connecticut Fish and Game Department.

On a walk down to the marsh, she pointed out where the cattail growing in the fresh water above the upper margin of tidal flow gave way to more salt-tolerant plants nearer to the river and its seawater. This variety of habitat in a narrow compass favors a greater number of animal species than does a more uniform area. The "edge effect" leads to a greater variety of foods and an interchange of animals between areas. In woodlands, openings are sometimes purposely made to provide "edge" for wildlife.

As we walked, Ruth enumerated the birds that might appear on the Hammonassett marshes—clapper rails, marsh wrens, marsh hawks, bitterns, swamp sparrows. Muskrats dig into the riverbank and deer wander across. Black ducks and mallards nest there, but one will never see a great flock, just scattered individuals that hunters push out toward open water in the fall. Af
hunting season the ducks move ba
into the marshes again until co
weather drives them out altogeth

Perhaps the greatest benefit of t
salt marsh is the food produced on
which is then consumed in the est
ary or open sea. The fresh water a
the tide meet so that the water ro
down and churns up a bath of nut
ents for the shellfish, plants, and fis
Offshore, those ducks that overwi
ter in great "rafts" are dependent
the coot clams, snails, and sea lettu
that live on the nutrients flowi
seaward from the salt marsh.

Ruth participates in the annu
bird count for the eastern flywa
that band of land down the east coa
that serves as a highway for migra
ing ducks and geese. Every year,
the second Monday in January, wil
life biologists along the coast ta
airplane counts of the waterfowl
and down the shore. I suppose
must become routine after a whil
but Ruth tells me that if the airplan
starts to pitch and drop in wind
weather, it quickly becomes excitin
again. Once she saw two bufflehead
perky little black-and-white duck
take off suddenly and collide hea
on in midair. Stunned, they droppe
to the water before floating apar
each undoubtedly thinking the othe
a bufflehead indeed.

There cannot be too many corne
of Megalopolis where one can stan
and say, "This is what it was like 5
100, 200 years ago. No rebui
houses with imported antiques, n
guides with modern haircuts an
antiquated dress; but standing o
this spot I see exactly what someon
who stood on this spot 100 years ag
saw."

The Hammonassett cemetery wa
according to the marker on th
stone gatepost, founded in 165
Within its stone fence is the histor
of gravestone style—from rud
scratchings on granite in 1724, t
sandstone, to marble, to granite
from bare names, to epitaphs, t
verses, and back to bare names an
dates once more.

At the back end of the cemetery
where an old apple tree leans ove
the square-cut granite blocks of th
cemetery wall, I can stand and look
over the upper reaches of the Ham

ne Koerners aren't trying to save the world. st a little piece of it.

Romero is a small farm village ing to the mountains of Colom- South America. Poverty is ex- e. Illiteracy is almost total. Elec- y, sanitary facilities and run- water are nowhere to be seen, small children haul water from iver three miles away. There is iool in the district, but convinc- parents that education should precedence over water-hauling iard argument to win.

The Fuentes are one of the vil- families. Poor even by Romero's standards. The mud-brick house dirt floors they live in isn't even s. The two-acre farm behind it ides all the income for the fam- f nine. Most of the time there enough to go around. Yet, this been a good year for the Fuentes. r 7-year-old daughter Luz Ma- has been able to stay in school. This miraculous stroke of luck is use of a family living in New , who are helping Luz Marina. y're the Koerners. Through Save Children Federation, they are ributing $15.00 a month to help.

For Richard and Marianne Koerner the $15.00 a month is not an extreme sacrifice. Yet, with three robust boys of their own, there are many ways could use the money. But Rich- whose job involves foreign travel, n't have to imagine the poverty Fuentes endure. He's seen it. He ws, too, that Save The Children do a remarkable number of gs with the money.

First, Luz Marina's immediate ol needs are taken care of. Sec- ly, funds are available to the ily to carry out their self-help to raise hens. The eggs will help rove the family diet and in- se the family income. Finally, iall portion of the Koerner's con- ution, together with money from r sponsors, has been lent to the agers. With their own hands and at, they're building a water storage tank and a pipeline. Hopefully, the new water supply will increase the crop yield and the village's income so that some day they will no longer need help.

Self-help. That's what Save The Children Federation is all about. Although contributions are tax-deductible as a charity, the aim is not merely to buy a child a few hot meals, a new coat, or shoes. Instead, your contribution is used to give people the boost they need to start helping themselves.

Sponsors are desperately needed for children in Korea, Vietnam, Latin America, Africa, Greece, the Middle East, as well as Appalachian and American Indian children. You can select the child's nationality and will receive a photo, regular progress reports and a chance to correspond and visit.

Richard Koerner hopes that one day, one of his business trips will enable him to meet the Fuentes. Many sponsors do visit their children, and tell us that it is one of the most gratifying experiences of their lives.

The Koerners know they can't save the world for $15 a month. Just a small corner of it. But, maybe that is the way to save the world. If there are enough people like the Koerners. How about you?

National Sponsors (partial list):
Faith Baldwin, Hon. James A. Farley, Gene Kelly, Mrs. Eli Lilly, Paul Newman, Mrs. J. C. Penney, Frank Sinatra.

Save The Children Federation, founded in 1932, is registered with the U.S. State Department Advisory Committee on Voluntary Foreign Aid.

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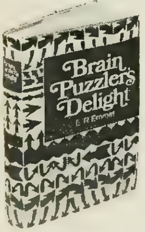

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monassett tidal marshes. The *Panicum* grass at the edge of a narrow strip of meadow gives way to the *Spartina* of the marshes. The river at low tide sinks down into the peaty mud of its banks to a soft, sullen flow. The sedges and rushes wave proudly beyond until they meet the wooded slopes on the far side of the marsh. Here it must look as it has since the cemetery was founded—the wind whistling through a gnarled spruce on the hill, grass stalks blowing against the ancient gravestones, briars growing over the decayed stone stumps of long-forgotten graves. And beyond the wall, the marsh looks as it did to Victorian ladies in black organza during Sunday afternoon cemetery visits, to colonials leading their oxen to pick up the salt hay, to Indians passing down the bank to spear eels.

Yet the whole marsh is broken into multiple ownerships, some being held for speculation. Probably within the short few years of our lifetime it will disappear, and the Hammonassett can do no more than say, with Mr. Abram Hill who died September 30, 1840, age 77,

> "Farewell my friends my memory
> keep. While in death's armes my
> body sleeps."

The edible blue mussels gather in colonies just above and below the low-tide mark, each attached to the substrate by the fibrous anchor lines of its byssus. With the decline of the oyster and with an increasing number of clam beds declared off limits because of pollution, the mussel may eventually be the main collect-it-yourself shellfish along our shore.

At low tide, clusters of blue mussels, which may also be black or dark brown, can be seen in the shallow water clinging to rocks, submerged logs, and mud flats.

The mussels spawn from late spring through the summer. The female mussel, influenced by rising temperatures, releases millions of eggs into the water. Fertilized by the males, these eggs are carried about by the currents. Within a day, a fertilized egg develops into a microscopic larva, and before a week is out, the young mussel larva is able to swim rapidly. The prodigality of nature is not wasted, for millions of the young larvae serve to feed the numerous animals that filter the

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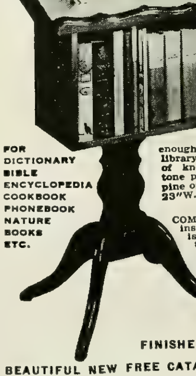

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water for food. The adult mussel replies in kind, for in pumping about ten gallons of water a day for its own feeding, it may account for 100,000 barnacle larvae every twenty-four hours.

Gradually the first evidence of a shell appears, and before two months have passed, the young mussel settles down. It anchors itself with the byssal threads formed by a glandular secretion and begins to grow and mature. Where it settles depends, in part, on the vagaries of wind and wave. Onshore waves wash the larvae over the surfaces where they can attach. If the waves are too high, the young will be transported above the normal tidal flow and be left high on the shore where they soon die. If too many are deposited at any one point, competition for the available resources will mean the certain death of many individuals.

Even the adults are not free of all danger. Although those below the low-tide mark do not have to close shut twice a day with each tide, and therefore have longer to feed, they are the prey for many other animals in the water These predators move up with the rising water to feast on those mussels situated between the tides. As the water recedes, birds come to the shore to pick over the mussels waiting for the next tide.

The beach at Hammonassett State Park is a long sandspit on Long Island Sound. Behind the beach are parking lots and campgrounds for hundreds of tents and trailers. In back of all this, and running to the Hammonassett River, are acres of salt meadow. This level land is subdivided by ditches that drain off the water from the pools where salt marsh mosquitoes breed. The meadows sit alone and lonely, penetrated only by the occasional hunter or hiker. The mosquito ditches act as moats, and deter all but the most determined wanderer. This background serves as cool, open space away from the bustle of the crowded beach. It is also potential space for filling, dumping, and dredging.

The state dump at Hammonassett is at the head of the narrow valley that is part of, and leads out into, the salt meadow. The highland at the edges of this small valley is covered by red pine on one side, cedar on the other. Bordering the trees, there are

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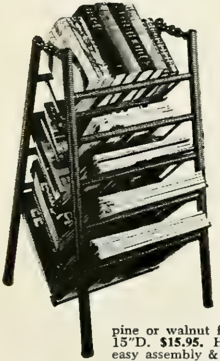

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shoulders of tall *Phragmites* reed, which in turn taper down to the shorter sedges.

In the best tradition of sanitary land fill, a field of sand, grooved by rivulets and the ruts of car tracks, slopes to the edge of the dump. At the edge, it drops abruptly down to the reeds and salt meadow. At the top of the slope are decayed and burned fence posts, discarded boards, parts of three cars, the remains of a pink upright piano, the cab of a pickup truck, several mattresses, four couches (one, a particularly repulsive faded salmon-purple color), beer cans, bottles, and a *Sports Illustrated* whose pages are interleaved with pictures of naked women cut from some other magazine. A small bird chirps in the reeds, three gulls fly by in the sunlight overhead, and another bird perches and teeters on the wires strung on poles across the little valley.

The ancestors of laconic Yankee Dan Willis were cutting salt hay on the salt meadows more than a hundred years ago. It was used for forage by the first settlers and later, for bedding cattle, but with the decreasing use of animals, salt haying went into a decline, which was hastened by the mosquito ditches that made much of the meadows inaccessible. In recent years there has been a better market as suburban gardeners demand it for garden mulch. Salt hay, *Spartina*, is particularly useful, for it doesn't seed in a new crop of grassy weeds like regular hay.

To the experienced, harvesting salt hay presents no special problem, but let the incautious beware. I was once exclaiming over the high cost of salt hay, more costly than the best alfalfa, when a farmer spoke up for the prevailing state of things. He told of the time his family decided to harvest the salt hay on an obscure piece of marshland they owned. Cutting was difficult. The thick and matted hay kept clogging the cutter bar of the mower and the machine periodically bogged down in slippery mud. Finally all was done; the hay cut, dried, and stacked to be taken away the following day. That night there was an onshore wind and a high tide, and all the carefully gathered salt hay floated out to sea.

When I repeated this story to Dan Willis he listened without commen He treats salt hay just as he doe regular hay: cutting, baling, an storing. He paused before addin that one must also consult th Farmer's Almanac. He then gaze out over his meadow while waitin for the question I had to ask. Th answer was simple. The Farmer' Almanac gives the height of th tides. Salt hay has to be cut at th lowest tides, for a high perigee tid can wet the hay or wash it away.

The rising scientific interest in sal marshes and estuaries must be nearing flood tide with the recent publication of a 757-page tome on *Estuaries* by the American Association for the Advancement of Science. Studies of increasing complexity and detail (invariably described as "more sophisticated") suggest the same conclusion. Salt marshes are of great biological and geologic interest. They have tremendous productivity and are probably essential to much of the offshore sea life.

Acre for acre, salt marshes are equal in total production to the highest-value croplands, even when the latter are aided by all the science and art of man. This nutrient production comes not only from the obvious plants but also from the minute algae that grow on the mudbanks of the tidal creeks and ditches. The larger marsh plants die and break down into detritus, minute organic particles that serve to feed the animals of the estuaries. A study in Georgia showed that 45 percent of this plant production is eventually lost to the tidal waters that flow through and over the marshes and is carried to the animals in the streams, estuaries, and oceans. The users of this food production, therefore, are far removed from its source. Like our great cities that depend on the remote wheat fields of the plains for sustenance, the cities of sea animals —which we draw on for food and sport—depend on the marshland. These animals can be shellfish, crustaceans, or fish. The Niantic River estuary, for example, provides about 300 pounds of scallops per acre per year, which is more than the beef yield on good grazing land.

Moreover, the marshes and tidal inlets serve as necessary nurseries for many kinds of fish that are later caught as adults farther out to sea.

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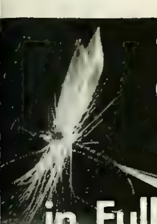

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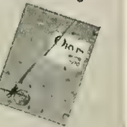

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The full story has yet to be worked out. Sally Richards and W. G. Pearcy, working in the nearby Mystic River estuary, found 59 species of fish, including the eggs of 13 species, the larvae of 26 species, and the juveniles and adults of 51. Menhaden, striped mullet, and winter flounder may be totally dependent on the marshes when young. If the marshes go, the flounder go.

Early in December, I walked near the mouth of the river. After looking for a little while at great creosoted piles being driven for new marinas, I stood and watched the oily water float by. A cardboard sign nearby proclaimed that any discharge in these waters was strictly illegal. As I read the sign, the periods were accented by the pound of the pile driver as it drove its stake deep into the mud. The pile driver was a large tracked vehicle and probably not as remarkable as many other modern machines. Yet with the assistance of only two men, bundled in red-checked wool against the winter wind, the machine swung out to the higher, graveled parking lot, plucked a twenty-foot post from a pile and lined it up for driving. Ker-blam. Ker-blam. The post sank down until it receded into line with the others.

The margin of the shore dropped sharply down to the oily water. Wooden floats stretched out to provide mooring for the many boats drawn up to await spring. At my back, a few last weeds rattling in the wind pushed through the dirt and gravel. Farther up the harbor a ten-foot dike of dried mud held back the dredged spoils that covered the old salt meadows. The pile driver worked slowly toward the dike. The machine did not need to hurry. Next summer or perhaps the summer after, the dike would be bulldozed down, more piles would be driven, more floats would be launched, more oil would be spilled, more progress would extend up the Hammonassett River.

I turned and walked along the empty harbor. Old colonial houses were juxtaposed with summer cottages and cheap apartments. A few yards from the shore a motel had built a swimming pool. The remains of summer's trash blew by on the wind, but it was quiet in December—it was deathly quiet along the Hammonassett River shore. ■

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The Rise and Fall of Progress

by Jerome Lettvin

The Coming of the Golden Age: A View of the End of Progress, by Gunther S. Stent. *The Natural History Press, $4.95; 146 pp.*

Gunther Stent holds that we have reached the heat-death (*Wärmestod*) of the spirit. Not only are science and art at the end of their progress, but the force that drove them, the will to power, is played out, bred out, trained out. His description of our present state is faultless; no practiced eye could miss the symptoms—the plucking at the coverlet, the disconnected mumbling we all noted at the American Association for the Advancement of Science this last Christmas.

Stent argues from the apathy that today afflicts any son of a dogma. For who will deny that genetics and molecular biophysics have run their course, now to mummify as an engineering subspecialty? But he sees, too, the decay of spirit in physics and mathematics, those archetypes of all science. (He excepts only, as a possibility, a science of nervous action. That, I believe, is only because he doesn't know much about the field: it is a genetic marvel, an example of total inherited sterility.) What has happened is that the goals of science have become unclear. "What, actually, would it *mean* if one understood the origin of the universe?" asks Stent. "And what would it mean if one had finally found the most fundamental of the fundamental particles?" The goal is hidden "in an endless, and ultimately tiresome succession of Chinese boxes." One has a vision of hordes of pale scientists wandering like the undead, bound by pointless rules, and fed, not so much by human blood as by printed lists of its composition. I do not have any competence in exact science, only friends who profess it. Stent's view is just, by what they say. The case is similar with the arts, but I prefer to stay with his treatment of science.

I cannot be as pessimistic on this point as is Stent. His area of blindness is important to discuss. It is revealed by three citations in his text. First, he remarks that certain proteins (for example, those that form the head and tail structures of bacteriophage or those that form the flagellae of bacteria) combine in vitro to form the definite shapes from which they are extracted. Next, he quotes Eddington about the differences between a "physicist" (who must have prior theory to accept a fitting observation) and a "stamp collector" (who just likes to arrange observations like flowers). Finally, he presents Mandelbrot's analysis of the "spontaneous activity of a system," saying that it is of the utmost importance for cognition of the system, and then showing the difficulty of building an adequate observational base from which to say anything at all about complex systems where the mean values of observations do not rapidly converge to a limit.

These points characterize the attitude of most modern scientists, particularly the biophysicists. Such an attitude has resulted in the decay of all those amiable empirics, such as zoology, botany, anatomy, physiology, that once ornamented the schools while they distressed the students. Ramon y Cajal or von Humboldt would have difficulty getting into the biology departments at MIT or Harvard. For the feeling is, and it is really a superstition, that forms are easily accounted for once one knows the elements and rules for composing them. The particular shape that an insect has, and the particular sequence by which a tick drops onto a mammal, are deemed only combinations of ultimately describable elements that pose no paradox to physics. But the self-organization of proteins into a phage cage has as much relation to the making of complex animal forms as the bonds that result in an alphahelix have to the rules of growth of a snail shell. Such relations are, to put it precisely, metaphorical. The great problems confronting quondam physicists, as well as stamp collectors, are the classical questions of long-range order—the rules by which a macroscopic object is inherent in the description of its components. Crystallography, which is the simplest case, is already difficult to handle.

The absurdity of using Mandelbrot's approach to complex systems is analogous to considering statistics on the occurrence of phonemes when a man is reading the Bible aloud. For who will deny that the Sabbath lesson is spontaneous activity in that complex system, man? If the mean values of observations do not converge rapidly, possibly the goal of the observation is improper if you want a theory about th system observed. On the other hand, i all you seek is a theory of making th best of indifferent modes of observation, then Mandelbrot's work is ver relevant. His study alone is sufficien to indict our colleagues in the socia sciences and their absurd approach t understanding the society: they, wit their Golem computers, spawned b Jonathan Swift out of Tom Swift.

What I am trying to say is that i Stent rests his case only on the reducibility of all natural science to physic and the death of progress in physic itself, he is beating a dead horse. It i one thing to say that the rules of physic must not be violated; it is entirely different to suppose that if the rules o physics are not violated, then, *a fortiori* biology is an example of the use o physical law and is, thereby, not interesting. This is tantamout to examining Shakespeare for forbidden sequence of letters, for example, *-qx*, and then retreating in boredom when we find no surprises or paradoxes. And, certainly, all of Shakespeare is writ with English letters. To suppose, next, that letters can be linked together by some rule to form Shakespeare's works, and that this rule depends on the characteristics of the letters themselves, is to say very little about Shakespeare's works. Nothing much is revealed about Shakespeare if I shake up the two letters *n* and *o* in a dice box and then show that however they appear in sequence, they form a word.

The funeral of physics is not the suttee of all sciences, but only of all those that depend analytically upon it. There is an entirely different set of sciences, unmentioned by Stent, that can properly be called synthetic. They are metaphysical, deal more with laws of mind than of particles, more with information (in the most general meaning) than with energy. Physical laws hold no great constraint upon these sciences. To answer the question, how is perception possible? it is not enough to give a wiring diagram of the brain and the state function of the external world. What is required in addition are rules for operation and the relations of these rules to each other. I

vould be very surprised to learn that uch rules could be expressed as sets f chemical bonds, for instance.

These objections are really acalemic, because in a practical sense Stent is correct, and contemporary cience and art *are* dead, but continue o talk through suggestion or habit. The success of past progress in physics nd its dependent engineering appliations have changed the world so nuch that alternative approaches are ardly possible any more. Even the artists have bought the dictum that we are hypostasized in uncertainty; we move by conditional probabilities; we bear the same connection to underlying conditions as a spot on a film bears to the photon buried there. We are all, every one of us, particulars illustrating a norm. The death of aesthetics lies in the conviction that it makes no difference which note is where, which word follows another. This view is, of course, a caricature of what science, means, but, except for Herman Weyl, whom nobody reads anymore, what scientist looks seriously at perceived forms as the elementals?

Professor Stent goes on from the death of progress in science and art (about which he is, in principle, more pessimistic than he should be) to the death of spirit, the stasis of society. And here he is more optimistic than he should be. He uses the beatnik and hippie as indices of social response to the decay of progress and to the limit of creative knowledge in the world. He sees the future in terms of beat and hip herds, cropping consumer goods on the great plains of the city streets and chewing their mental cuds on acid and pot. A few squares would keep the wheels rolling and act the Disney version of Dr. Faust. He supposes that lack of interest in the world could become sufficiently endemic that nuclear holocaust would be averted. He sees, in a word, that Faust's *verweile doch—du bist so schön* actually expresses the leisured hell to which we've come through the whole damned drama, at once the reward and punishment for having been Faustian man. The *verweile doch* is equivalent to giving up the will to power, to the release of Ariel by Prospero; and we become as buffalo.

Stent apparently has not seen the metamorphosis of our young to a new instar—the activists, the radicals. What characterizes their political action is that, for the first time in history (outside of some early Christian sects) there is a revolutionary movement that renounces any structural goal. Just as one could not imagine what it would *mean* to know the origin of the universe, so, too, one cannot imagine what social conditions would satisfy the present revolutionist. There are not even fake ideologies to play with. One can take on the trappings of Stalinist or Trotskyite, anarchist or Spencerian social evolutionist, but no more seriously than one would wear Edwardian clothes as a kind of identifying mark. Yet all their actions are consistent if not deliberate—the left-wing revolutionaries deny any structural goal except destruction of the system. "Power to the people" is a serious matter; they do not presume to say what should be done by that power, only that it should be released and shaped from day to day. It is a Quixotic madness that I like rather more than the constipated selfishness of right-wing radicals who sport the motto: "What has posterity ever done for me?"

In any case, with many of these radicals the will to power, for lack of any solid stuff to push around—the absence of "participatory politics" in any contemporary government—is without purpose, like a mixing machine that one forgot to fill. And precisely because there is no reason for doing politics, any more than for doing art or science, the world will go, by default, to them. And we thereby may end up, not in Polynesia, but in Bedlam—and chained if we are not blown up first.

In summary, I wish to say that Gunther Stent's book is absolutely first-class. He foretells that we are entering a dark age as bad as what came on in the first millennium A.D. His argument is compelling, although I disagree with some details. It is a book of civilized despair at an unavoidable situation—it is not a jeremiad. One cannot be sure whether the world is more likely to end with a whimper than with a bang. Professor Stent inclines to the former view. For almost religious reasons I hope he is right, because then there still might be a renaissance. However, I am not convinced by his optimism.

Dr. Jerome Lettvin is professor of communications physiology and a lecturer in the Department of Humanities at the Massachusetts Institute of Technology.

PREHISTORIC ANIMALS AND THEIR HUNTERS, by I. W. Cornwall. *Frederick A. Praeger, $7.50; 214 pp., illus.*

Widespread interest in man's Pleistocene life had developed even before Robert Ardrey's *African Genesis* titillated the cocktail circuit with the thought that all of us are sublimated killer apes with a weapons fixation. Pleistocene experts in paleoecology and archeology must now make way for psychologists and ethnologists, among others.

Most of the 110 billion people estimated by Edward S. Deevey, Jr., to have walked the earth, lived in ignorance of agriculture (*Scientific Amercan*, 1961). Thus any genetic control of human behavior should be sought in the selective forces operating on the prehistoric hunters. A few hunting-gathering people remain, perhaps 30,000, doubtfully representing the horde of the Ice Ages.

For example, the surviving hunters now rely on meat less than one migh expect, at least in the low latitudes According to Richard B. Lee in *Man the Hunter*, the !Kung Bushmen o South Africa get only a third of thei caloric intake from meat; the rest is obtained from plants, mainly mongongo nuts gathered by the women. Both sexes enjoy considerable leisure time, with an average of only twelve to nineteen hours a week devoted to getting food. Starvation is not much of a threat even when drought strikes. The aged are respected and senilicide is extremely rare.

Not much encouraged by looking for a key to the past in present cultures, one returns to the flakes, blades, broken bones, charcoal, and masterful Paleolithic art that represent our Ice Age inheritance. Cornwall recaps the geology, prehistory and, above all, the vertebrate paleontology of the last several million years, letting the ancient hunters furnish his illustrations.

One learns, or is reminded, that even in a primitive, savage state man is the most adaptable of animals, modifying his habits to suit his habitat and ultimately modifying both. The prehis-

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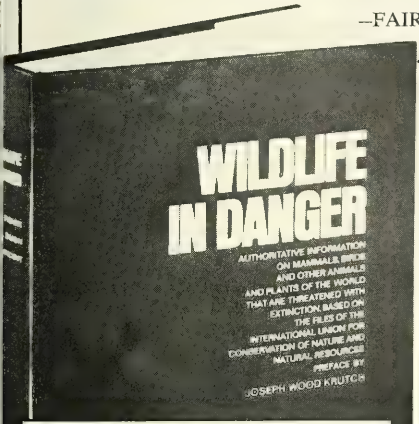
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City________________State________Zip_______ toric weapons race ran from pebble tool to handax, spear, and bow; undoubtedly other weapons of destruction, such as fire and poisons, were used. While extinction was the fate of many large animals, especially in the Americas, it was not a hazard for man himself despite the constant danger individual hunters endured. Carnivores, seldom man's prey or predator, may have suffered as his unwitting competitors.

In the Introduction, Cornwall notes that species threatened with extinction in our time are only the successors of many more that have died out, largely from natural causes in the more or less distant past. Yes, yes; but there is more to it than that, and what may have been true for the dinosaurs may not help explain the fate of the mammoths.

In the text Cornwall glibly states that reindeer moss is an essential part of reindeer diet (no single species of plant can be so regarded for any large herbivore); that the roman-nosed saiga exist only in small numbers (true in the time of the czars, but the Soviets are very proud of having rebuilt the herd to some three million); that beaver are indicators of a boreal climate (until being trapped out in the nineteenth century, they ranged south into the Sonoran Desert and the lower Rio Grande); and that mastodonts reached the most northern parts of South America (they ranged widely throughout that continent).

While Cornwall is more sensitive to the Pleistocene features of Europe, where he is on home ground, I'm not ready to believe that fossil hippo are sure indicators of a frost-free climate or that Eurasian musk-oxen were finished off by hunters with firearms after successfully resisting attacks by Stone Age hunters. Cornwall is not guilty of as many moot points as the above collection might suggest, and if he were provocative, à la Ardrey, I could forgive him. Mostly he is bland—bland about a subject thoroughly fascinating and at times marvelously mysterious. As Ardrey realized, a Pleistocene scenario deserves more.

PAUL S. MARTIN
University of Arizona

Briefly Noted:

NORTH AMERICAN BIRDS, by Lorus and Margery Milne. *Prentice-Hall, Inc., $25.00; 340 pp., illus.*

The paintings of Marie Nonnast Bohlen and the commentary of Lorus and Margery Milne have combined to produce a truly beautiful book of birds that should prove irresistible to anyone with more than a casual interest in the subject. Covering more than 300 species, the book is divided into habitats (swamp, shore, forest, etc.), and discusses migration habits, song, food, and plumage. For some species th book may someday serve as a memori rather than a guide, for the Miln have included a notable number of e dangered birds. Though the price of th volume is high, in this case, it is we worth it.

THE HUDSON RIVER, by Robert Boyl *W. W. Norton & Co., Inc., $6.95; 30 pp., illus.*

For those who think of the Hudso River as a sewer separating New Yo from New Jersey, Robert Boyle ope up undreamed-of vistas. Boyle cove the Hudson, section by section, unfol ing the incredible diversity of anim and plant life that populates the riv as well as the varying terrain that form its shores. Far from mourning the Hu son as a dead body of water, Robe Boyle celebrates its amazing vitalit Although heavily polluted in som areas, it still abounds with striped bas bluefish, carp, yellow perch, and se sturgeon—to mention just a few. Th author details New York State's abus of the river and offers a very illumina ing chapter on the battle to stop Co solidated Edison from building a powe plant at Storm King Mountain. A fu bibliography is provided for those wh wish to pursue a particular aspect o the book.

THE WORLD OF ANTS, BEES AND WASP by Brian Vesey-FitzGerald. *Transa lantic Arts, $6.25; 117 pp., illus.*

Aside from a sometimes militantl anthropomorphic attitude, Mr. Vesey FitzGerald does provide a thoroug survey of the lives of the social insect —ants, wasps, and bees. The writing i clear and interesting when the autho sticks to the subject, but his philo sophical meanderings are somewha distracting. "Oh, how anthropomorphi can you get?" asks Mr. Vesey-Fitz Gerald at one point. Just read the boo and find out!

C.B

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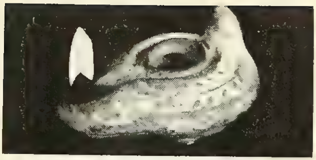

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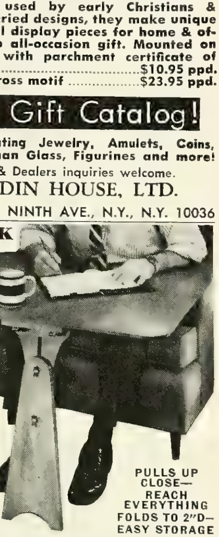

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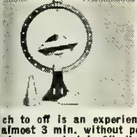

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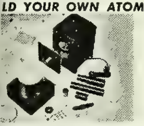

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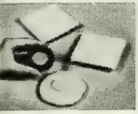

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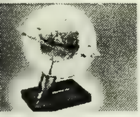

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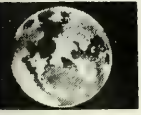

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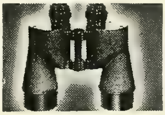

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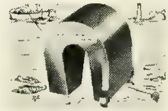

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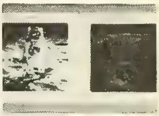

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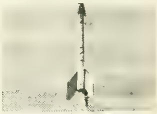

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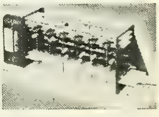

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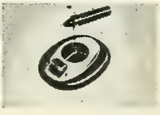

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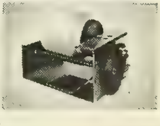

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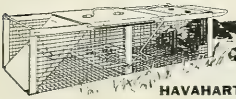

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OUR PLUNDERED PLANET. F. Osborn. Little, Brown and Company, Boston, 1948.

PERILS OF THE PEACEFUL ATOM. E. Hogan and R. Curtis. Doubleday & Company, Inc., Garden City, 1969.

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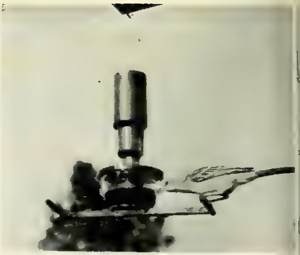

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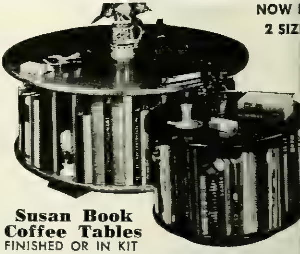

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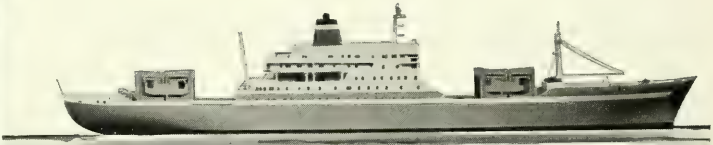

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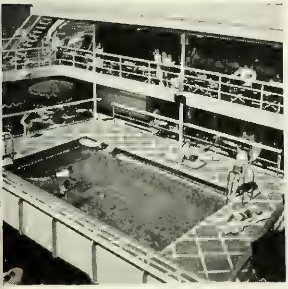

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Publication Office: The American Museum of Natural History, Central Park West at 79th Street, New York, N.Y. 10024. Published monthly, October through May; bimonthly June to September, Subscription: $7.00 a year. In Canada and all other countries: $7.50 a year. Single copies $1.00. Second-class postage paid at New York, N.Y., and at additional offices. *Copyright © 1970 by The American Museum of Natural History. No part of this periodical may be reproduced without the written consent of* NATURAL HISTORY. *Manuscripts and illustrations submitted to the editorial office will be handled with care, but we cannot assume responsibility for their safety. Opinions expressed by authors are their own and do not necessarily reflect the policy of The American Museum.* NATURAL HISTORY *incorporating* Nature Magazine *is indexed in* Reader's Guide to Periodical Literature.

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SCANDINAVIAN AIRLINES

THE AUTHORS

The personal analysis of the social side of a conservation problem is the result of **Alan Ternes**'s "journalistic odyssey," which encompassed Beaufort County, Columbia, Charleston, and Hilton Head Island, South Carolina; as well as New York City. A former newspaper photographer, reporter, and editor, Mr. Ternes is presently a Ph.D. candidate in geography at Columbia University. His previous work for NATURAL HISTORY includes a two-part article on Ethiopia (February, March, 1968) and the NATURAL HISTORY Special Supplement, "The State of The Species," of which he was editor.

Pennfield Jensen's "A Student Manifesto on the Environment" is partially based on the paper he presented at the recent conference of the United States Commission on UNESCO: "Man and His Environment, A View Toward Survival." Executive director of the Urban Nature Institute for Youth (UNIFY) and a teacher at the Center for Environmental Education, San Francisco State extension, Mr. Jensen became acutely aware of the need for environmental reform by observing the vast influx of population and the destruction of the countryside near San Francisco, where he grew up. His principal concern is with the development o meaningful curricula for the undereducated and environmentally underprivileged. Mr. Jensen's article "Ecotactics" will be published this year by the Sierra Club.

Thomas Gladwin's article "East is a Big Bird," the second part of which will appear in the May issue, stems from his 1967 field work on Puluwat, a smal Pacific island. His research focuses on the logic behind Puluwat navigation and its implications for an increased understanding of the thinking processes in educationally disadvantaged people in the Unite States. Currently visiting professo of anthropology at the Universit of Hawaii, his future research wil include comparative studies o postcolonial imperialism as a limiting factor in national development Professor Gladwin's forthcomin book, *East is a Big Bird: Navigation and Logic on Puluwat Atoll* from which his article is taken, wil be published later this year by Harvard University Press.

Peter van de Kamp, the author of "Barnard's Star: Th Search for Other Solar Systems," has been associated with Swarthmore College since 1937. He is currently chairman of the Departmen of Astronomy and director of th Sproul Observatory. Born in th Netherlands in 1901, Professor va de Kamp came to the United State in 1923 to carry out research at th McCormick Observatory, University of Virginia. The author o *Basic Astronomy, Elements of Astromechanics,* and *Principles of Astrometry,* he was appointed to th National Science Foundation i

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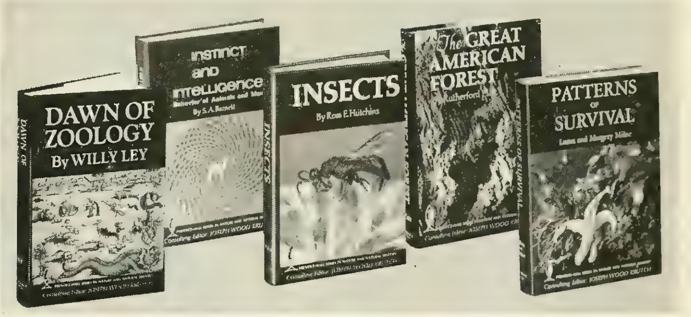

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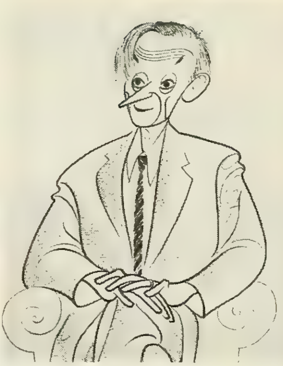

1954 as the first program director for astronomy. His article sums up the eighteen years of research that led to his 1963 discovery that Barnard's Star has one or more unseen companions of planetary size.

A native of Victoria, Australia, **D. J. Mulvaney** completed a master's thesis on British Iron Age prehistory at the University of Melbourne in 1951, and two years later received an M.A. in archeology from Cambridge University. Since 1955, he has participated in field surveys and excavations in various parts of Australia, and last year, he worked in Sulawesi on a joint project with the National Archeological Institute of Indonesia. At present, Mr. Mulvaney is a senior research fellow in prehistory at the Research School of Pacific Studies at The Australian National University. The author of *Australian Archeology: A Guide to Field Techniques* and *The Prehistory of Australia*, Mr. Mulvaney will spend this year at Oxford writing a biography of Sir Baldwin Spencer, the famous anthropologist of aboriginal Australia.

"The Many Clocks of Man" is the latest of several articles on biological rhythms **John D. Palmer** has written for NATURAL HISTORY. During 1963 and 1964, Dr. Palmer studied at the University of Bristol, England, as a National Science Foundation Fellow. He earned his doctorate at Northwestern University in 1962 and is now professor of biology and chairman of the Biology Department at New York University.

Miriam Rothschild was born in Ashton, England, a member of the famous banking family, many of whom were also keen naturalists. Her uncle amassed a worldwide collection of animals and insects, including 2½ million butterflies, and this collection aroused her early interest in the Lepidoptera. "Heart Poisons and the Monarch," her third article for NATURAL HISTORY, is coauthored by **Bob Ford.** Dr. Rothschild has written over 160 papers on varied subjects, ranging from the parasites of snails to mimicry in scent and sound. She is joint author of a popular book, *Fleas, Flukes and Cuckoos.*

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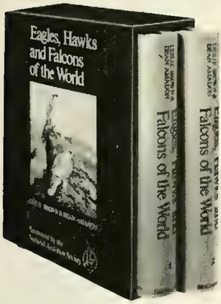

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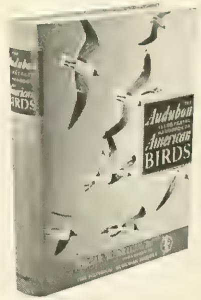

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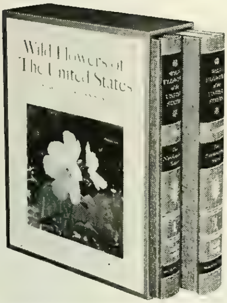

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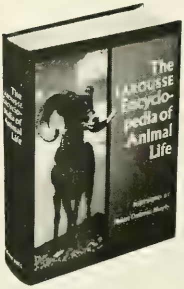

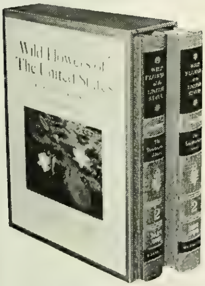

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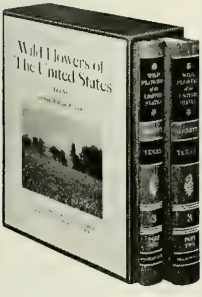

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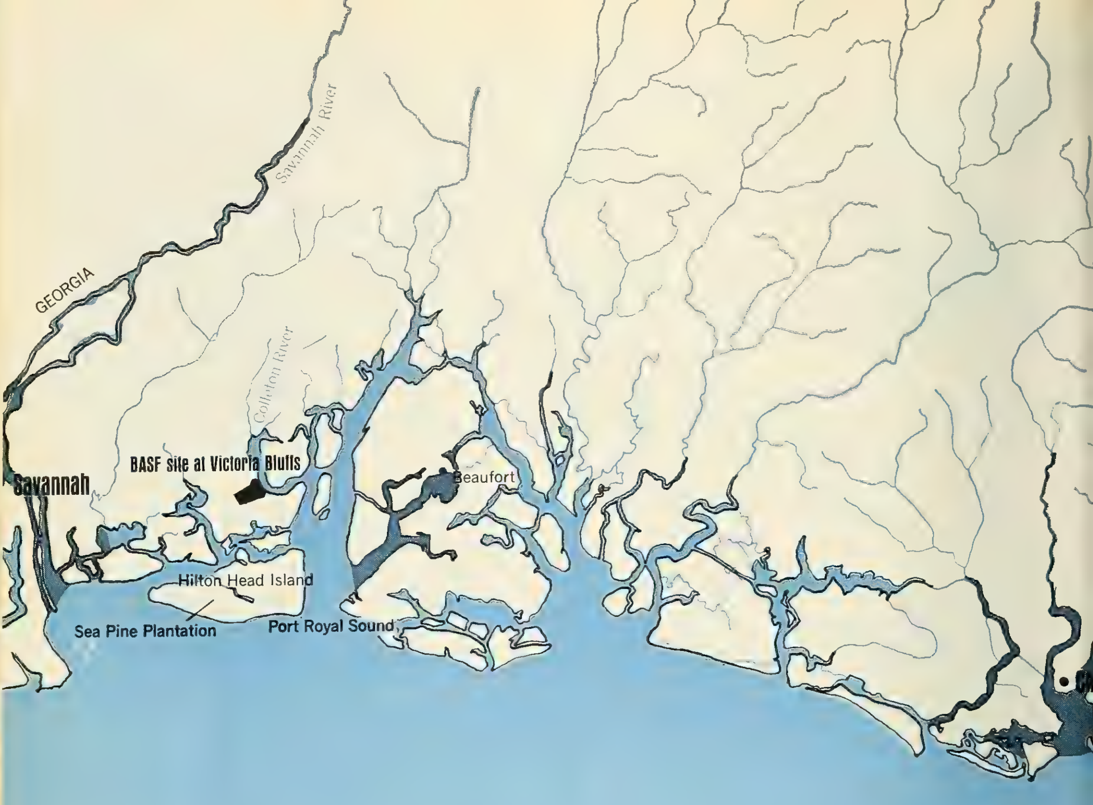


An introduction to the setting and characters of th

by Alan Ternes

South of sand-yellow Victoria Bluffs, on the Colleton River in Beaufort County, South Carolina, lies an 1,800-acre plot of second-growth woodland and salt marsh. It is a nondescript site, its young trees barely beginning to win out over the dense underbrush that took over after it was lumbered off.

"I wandered through there for half a day and couldn't find anything to photograph," complained a *Life* photographer recently.

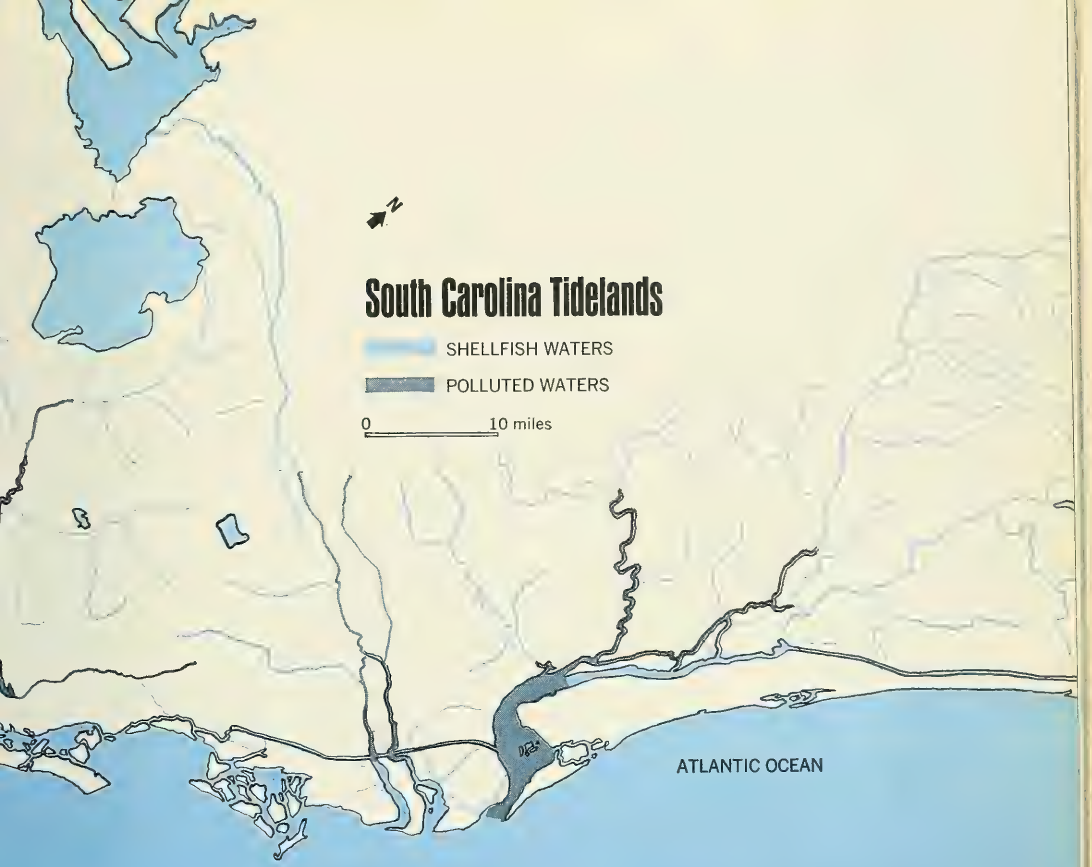
Yet hints of beauty exist, especially the deep-green, long-needled yellow pines, which have broken out of the canopy and are suddenly growing with an adolescent fervor that could lead to an elegant southern pine forest. But it is futile to describe the potential beauty.

Because the governor of South Carolina and most of his staff, most of the state legislators and probably most of the folk of Beaufort County look forward to the development of a complex of chemical plants on the Victoria Bluffs site. And the efficient management of the BASF Corporation, a German-owned chemical company in New York City, foresees the opening of the first plant in the final quarter of 1974.

A few Beaufort County residents, most of them living on nearby Hilton Head Island, have launched a quixotic campaign to prevent the construction of this complex.

The two groups—proponents and opponents—would make an appropriate cast for a modern version of a Shakespearean play, with Hamlet the ideal narrator. It is difficult to decide whether the drama would be a comedy or a tragedy. It contains elements of both: farce and buffoonery, deceit and betrayal.

Beaufort County, located along the deeply embayed coast between Charleston and Savannah, is a classic example of a troubled lowland area of South Carolina. A decade ago it was considered seriously depressed, with chronic unemployment, an aging, unskilled labor force, and poor public services. Its only trump card, which the area has played repeatedly, has been venerable Rep. L. Mendel Rivers, chairman of the



agical farce or farcical tragedy of Victoria Bluffs, S.C.

House Armed Services Committee. Congressman Rivers has repaid the perennial loyalty of his constituents by channeling funds into Beaufort County military facilities, which include the U.S. Marine training camp at Parris Island, a Marine air station, and a naval hospital. But even these boons provided few benefits for the many residents of the county, especially the large number of impoverished blacks, many of whom were malnourished, worm infested, and illiterate.

"Do you remember last year when they showed those colored folk in poverty on national television?" asked Eddie Boyer, executive director of the Beaufort County Development Commission. "That was right here in Beaufort County."

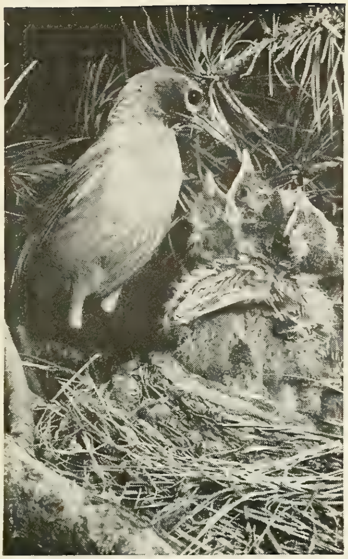
He was the first of many who spoke, with anger and shame, of the poor image the nation got of Beaufort County, of the way the television crews searched out the worst houses, the poorest-fed, sickliest children. Yet he admitted freely that the county had great poverty, that more than 20 percent of the population had family incomes of less than $2,500 a year in 1968.

"We want to do something for the colored people . . . . I never know anymore what they want to be called. I was raised to call them colored, so that's what I use. They need job opportunities and education."

Boyer, a short, jolly man, leaned back in his swivel chair. A clutter of papers, letters, and brochures lay scattered across his desk and on adjacent shelves. A map of the Victoria Bluffs site was mounted on the wall.

"We acquired the site in 1959," he said, "when the South Carolina State Ports Authority bought it for industrial development. The county has been trying to find a buyer since then."

Many firms had looked at the site—General Dynamics, Litton Industries, Bath Iron Works, Rockwell-Standard—but each time the deal faded. Several years ago Boyer and some other county officials visited the BASF Corporation in New York City and showed them an aerial film of the site and an adjacent



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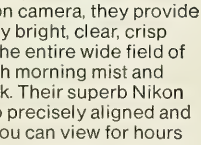

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area, Hilton Head Island. At the time, BASF turned down the site for the project they were planning. Two years later, however, the corporation decided to buy the site for another, greater project: a vast chemical complex with an original investment of $100 million.

Boyer thinks one of the crucial factors in bringing BASF to Beaufort County was the decision, about ten years ago, to make a freshwater canal from the Savannah River to Beaufort much larger than necessary. The federally subsidized canal was built partly to supply water to the Parris Island Marine Base. County officials at that time decided to construct a canal capable of carrying 125 million gallons daily, even though the maximum capacity of the Beaufort-Jasper County Water Plant is 9 million gallons a day, with future needs estimated at 24 million gallons. This left some 100 million gallons of fresh water a day available for industrial use, and so the development board could woo wet industries like the BASF dyestuffs and pigment plant, which will use some 2½ million gallons of water a day. Because the groundwater supply of the coastal plain is limited, the county could have attracted only dry industries if the large canal had not been constructed. Wet industries tend to pollute nearby waters more than dry industries, so the building of the large canal set the stage for high-pollutant industries to come to the county.

"BASF will broaden our economic base. Last year over half our income, $36 million, came from military payrolls. The other big industry was recreation, and everyone knows it is the first one to get in trouble in a recession.

"With this plant, we'll have steady, good-paying jobs. We figure there'll be 1,000 jobs in the plant, and 3,000 new jobs in service industries.

"It'll add more than $9 million to the tax base, and we need that. Most of the investment in the county is federal property, so we don't get any taxes from it.

"We'll have the finest technical training center in the state."

Boyer was warming up to his favorite subject. Someone knocked and stuck his head in the doorway. It was a junior public relations man from BASF. Boyer obviously had a busy schedule with the BASF people, including an appointment with Dr. Hans Lautenschlager, corporation president, who was making a goodwill tour. Boyer's secretary was just finishing a letter of welcome to Dr. Lautenschlager from the Beaufort County Chamber of Commerce, and arrangements still had to be completed for several speeches. Although I was anxious to leave, not wanting to interfere with these momentous events, I still had a few questions to ask Boyer about a touchy subject: pollution.

"I know the people at Hilton Head are harping on the pollution angle, but I don't think there'll be any problem," Boyer continued. "The company plans to have two stages of processing of the effluent. They've agreed to obey the state's pollution laws. What more can you ask of them? I visited their plants in Germany, and while I'm no expert, I didn't notice any pollution."

"A final question, what if the opponents stop the plant?"

Boyer hardened: "I'm a salesman. My job was to sell that site, and I did. I had the check for it right here, right in my hand. Nothing is going to stop the plant now. We're confident that we've got it tied up."

Boyer's visible agitation when he thought of the opposition to the industrial development was a good indication that the opponents were having some success. Because negotiations had been secret, there was no opposition when the BASF Corporation announced, on October 1, 1969, its plans to invest "$100 million in a vast industrial complex to be developed on an 1,800-acre site in South Carolina. . . ." A dyestuffs and pigments plant and a styrene polymers plant were scheduled to begin production in about three years. Site development was to begin immediately. But even in its first news release, the company tried to disarm potential opposition to its plans by including the following paragraph:

"Dr. Lautenschlager said that contrary to the usual pattern of events which follows the industrialization of any virgin area, BASF Corporation and the State of South

Not since the frontier days have merican Indians faced greater ts to their existence than they do .

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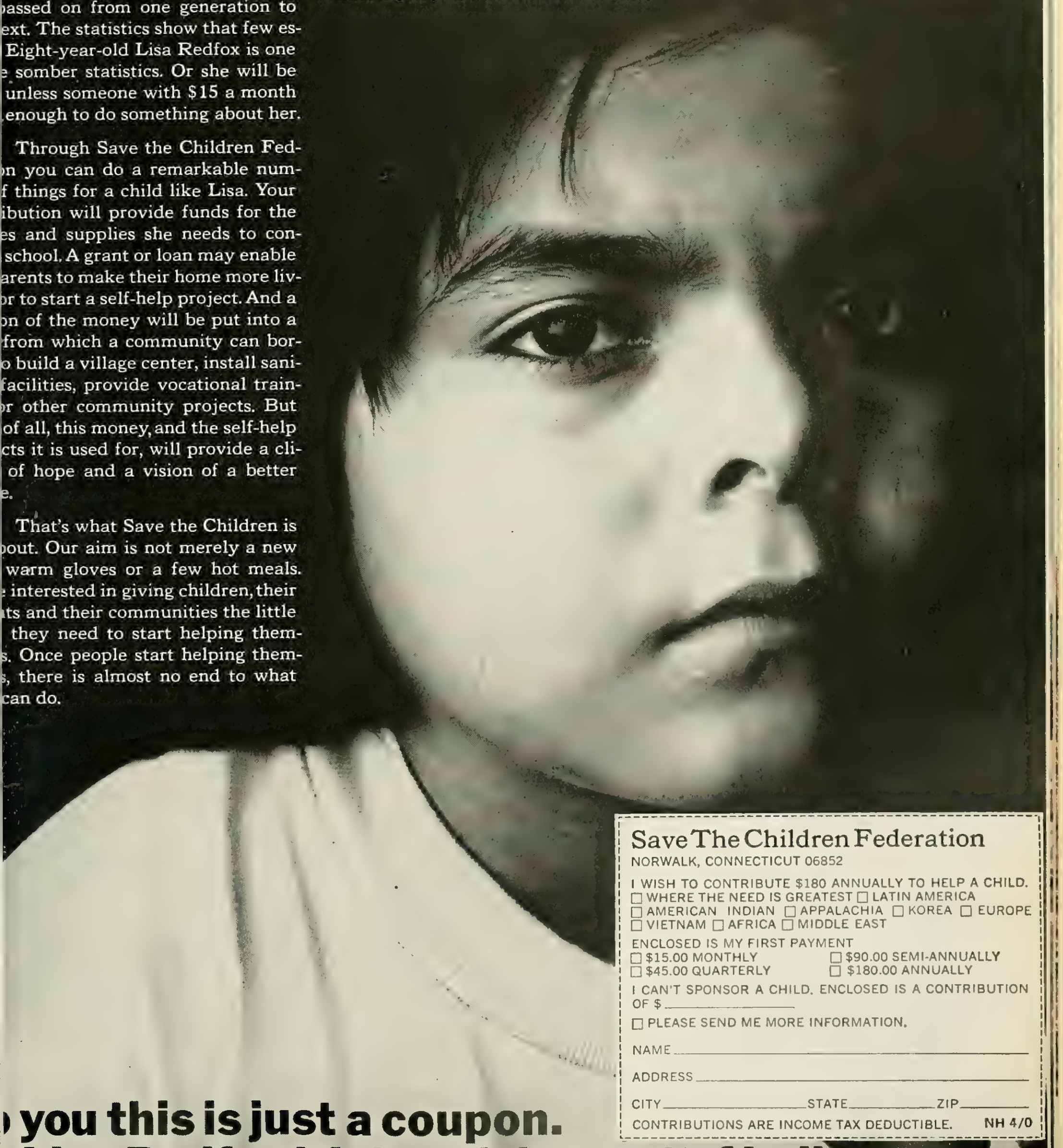

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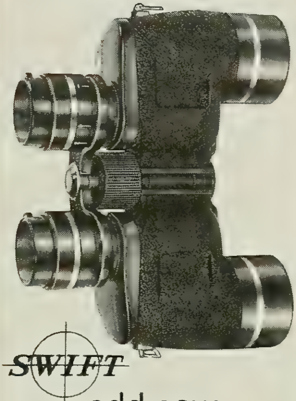

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Carolina are working together with the Beaufort County Council to develop a master plan which will preserve the ecology of Port Victoria. He highlighted the fact that considerable amounts of money have already been allocated for preventing air and stream pollution."

That statement is misleading. If, when it says "preserve the ecology," the BASF Corporation means to maintain the existing ecosystem, it is proposing to do the impossible. The daily effluent of some 2.5 million gallons from the dyestuffs plant, no matter how it is treated, will change the ecosystem. So will the dredging of a channel to the site.

A BASF press release a month later was more realistic when it quoted Lautenschlager as saying, "Development of the dyestuffs and pigments plant will at all stages adhere to the basic BASF policy of close cooperation with all relevant governmental authorities to assure protection of the total environment." This means only that the company will obey the South Carolina Pollution Control Law and the regulations of the state's understaffed Pollution Control Authority.

The residents of Beaufort County responded in a variety of ways to the BASF announcement. Some, like Boyer and officials of the State Development Board, saw the new plant as a great boon to the lowland economy. Many businessmen saw an opportunity for sales and profits, and most blacks saw a chance for good-paying jobs. But the members of a black fishermen's cooperative and many other residents of Hilton Head Island saw disaster. From this group slowly arose the organized opposition to the BASF plans.

The opposition groups have now joined forces under the save-the-environment banner, swearing oaths to ecology and nature; but the first impulses of many seemed to be directed more by self-interest than by lofty principles. For example, two of the most influential and well-heeled opponents to the BASF complex are Charles Fraser, a lawyer, and Fred Hack, a former lumberman. Both are now land developers and, together with their partners, they control a major part of Hilton Head Island.

Charley Fraser is dynamic, flamboyant, and successful. He has both political and financial influence. His development, the Sea Pines Plantation, has been cited for "Excellence in Private Community Planning," by the American Institute of Architects, and its success is envied by other developers. To live there, you would fit best if you were white, wealthy, semiretired, and a golf maniac. If you have had a lifetime dream of retiring to a tasteful, upper-middle-class home, surrounded by similar homes overlooking the ocean or a golf course, and if you can dig up $50,000 to $250,000 to finance your dream, you might like Hilton Head Island—the biggest coastal sea island between New York and Florida.

But if you want to be exposed to nature, to experience the natural richness of the semitropical environment of the southeastern coast, avoid Hilton Head Island. Because its developers—despite their pious proclamations about preserving the "natural beauty," about creating wildlife sanctuaries, about setting up an Institute of Environmental and Leisure Studies in a restored lighthouse keeper's house—are engaged in a ceaseless war with the natural world. Labor crews and tractors with brush-cutting rigs are constantly assaulting the undergrowth so that the landscape will have a parklike appearance despite the 300-day growing season. Dredging equipment has cut deep channels through many parts of the island, changing the drainage and destroying wet sites and their distinctive biota. Other areas are filled in with the spill from dredging. The result is that the natural fauna, such as deer, have been drive from much of the island and wil soon vanish. The turkey and dov populations are maintained fo sport shooting by annual restocking. The alligator population ha been greatly depleted. The flora—once distinctive and varied—is rapidly succumbing.

The developers' callous attitud toward the island vegetation reflect their heritage as lumbermen. The originally bought the island to lumber off its large stands of yello pine. Once, when Charley Frase was examining a plot of land wit a salesman, he came upon a beau tiful, mature pine tree standing in lonely splendor. "I wonder how we missed that one," Fraser remarked.

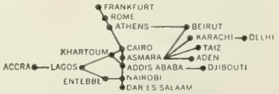
"It's a shame what they've done to that island," said a University of South Carolina biologist, one of a group of scientists that had surveyed the biota of the island two decades ago.

At Fraser's Sea Pines Plantation, the street names serve as a quaint reminder of the natural heritage. Many are named after birds that have been recorded on the island: "Ruddy Turnstone-2, Green Heron-4, Wood Ibis-6, Oyster Catcher-9, Black Skimmer-22, Royal Tern-24, Belted Kingfisher-34, Brown Pelican-37," and many more. The numbers, which run sequentially, were added later because many people complained that they were confused by all the bird names and could not locate the streets, much less recognize the birds.

A major imprint on the Hilton Head Island landscape has been made by the proliferation of golf courses. There are at present 135 holes of golf on the island, with several more courses planned. Since an 18-hole course occupies about 250 acres, nearly 2,000 carefully maintained acres of the island have been landscaped and planted. Ultimately, one-tenth of the island will probably be occupied by golf courses, which may be pretty by some tastes, but which certainly are not examples of natural beauty.

The building of golf courses is not just a crazy scheme of sports nuts. For the developer, the creation of a golf course provides many opportunities for homesites along the fairways. At Hilton Head Island the fairways are deliberately strung out to create a maximum amount of real estate frontage for housing. The prime sites on the eighteenth hole of the new Harbour Town Golf Course reportedly sold at the rate of $400,000 per acre.

The building of golf courses, extensive housing projects, condominiums, shopping and recreation centers, private road networks, plus all the additional features of Charley Fraser's 5,200-acre Sea Pines Plantation development, requires big money. Harbour Town, a new project in Fraser's complex, reportedly will cost some $30 million. The major source of funds for Har-



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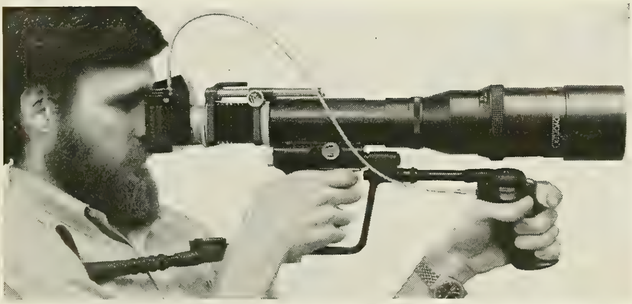

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bour Town and other Sea Pines projects has been Travelers Insurance Company of Hartford, Connecticut.

Obviously, anything that threatens such speculative, finance-heavy developments would cause great concern among its executives. And they generally believe that the construction of a chemical plant complex on the mainland some five miles from Hilton Head Island would be detrimental to the carefully conceived character of the region and would lower property values. Charley Fraser and other developers of Hilton Head Island are concerned about saving an environment, but it is an environment that they have created, and it is as far removed from the natural environment as are the conceptions of BASF.

Fred Hack has neither the flash nor the financial backing of Charley Fraser, but he does control more undeveloped land on Hilton Head Island than anyone. With his associates and through various corporate arrangements, he owns some 11,000 acres, most of it undeveloped. Some of Fred Hack's most picturesque property is on the northeastern part of the island, overlooking Port Royal Sound, and only a few miles downstream from the BASF Corporation's plant site.

"Fred Hack has a lot more at stake than Charley Fraser," one businessman on the island noted. "It's a simple matter of construction economics. If he develops his holdings and sells lots for $15,000 or more apiece, anyone who buys a lot will have invested $60,000 or more by the time he has built his house. But if the BASF plant goes in, that property won't be worth half as much. People will be investing $25,000 for a house and property. That would mean a totally different, a much cheaper, type of development, and a lot less profit for Hack." There is room for possibly 100 oceanfront lots—which may bring more than $100,000 each—along with another 500 lots adjacent to the beach on Hack's undeveloped property along Port Royal Sound. A little multiplication shows the multimillion dollar loss that a chemical complex might cost Hack and his associates. So it is understandable why Fred

Hack went along with his brother Orion's plan to oppose the BASF construction.

Orion D. Hack moved to Hilton Head Island in 1953 to sell property that his brother, who had lumbered out the area a few years earlier, was developing into residential sites. He is now vice-president and treasurer of the Island Development Company, vice-president of Port Royal Plantation, Inc., and a member of the board of Hilton Head Company—all parts of the corporate network that Fred Hack has developed. Orion Hack sincerely loves the natural world of Hilton Head Island; he has studied its bird and plant life in detail. He has tried to photograph in color every wildflower on the island, permanently recording them before they disappear. And he has probably been as disturbed as anyone by the gradual destruction of the natural fauna and flora. Yet for two decades, he has taken an active role in that destruction, and no doubt some of the lines in his friendly face have deepened because of the strains of that paradox.

Orion, who has put more soul and effort into the campaign to stop the construction of the BASF complex than anyone, recalls that he felt hopeless when he first read about BASF's plans. It meant the end of "one of the few large areas of estuaries on the East Coast unpolluted by industrial waste."

Then, with his brother's approval and financial support, Orion started reaching beyond the confines of Hilton Head Island and South Carolina for help. He felt that if he could somehow bring together enough concerned people, they could save the beauty of Beaufort County's unspoiled marshlands and estuaries.

"I called the scientists and naturalists that I knew. They, too, liked the idea, and their concern was so great that a chain reaction was created. Each person I contacted would give me telephone numbers throughout the country."

Phone service on Hilton Head Island is not quite, but almost, as bad as that on Manhattan Island. To make the hundreds of calls across the country that Orion made is a heroic feat. One of my perpetual images of Orion will be of his

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tall frame stooped over a telephone on a knee-high, corner table, waiting interminable minutes for a connection. Then his deep, Carolina-accented voice loudly introducing himself over the resistant circuit:

"Hello, sir. This is Orion Hack at Hilton Head Island in South Carolina. We have an estuarine pollution problem down here. . . ."

He called Barry Commoner several times. He called the attorney general of Illinois. He called the editors of conservation magazines. He called people at the American Forestry Society, the American Littoral Society, the Audubon Society, the Friends of the Earth, the Isaac Walton League, the National Wildlife Federation, and the Sierra Club. He called scientists at universities and research institutes. He called county, state, and national government officials. In return for their participation, he offered the free, plush hospitality of the Port Royal Plantation Inn and free transportation to and from Hilton Head Island. After two weeks of calling, Orion had a sore ear—and a symposium.

A few days after the symposium, when Orion and others realized that I was really interested in learning more about the countryside and the BASF plant site; about poverty and children with worms; about the island, its developers and its golf courses; they became less open and more cautious about what they would say. At times they were more honest, as when Orion changed roles suddenly one day and said, "We developers don't have to fight so hard to save Hilton Head. We could sell and get out. We don't have to stay here."

Then his almost defiant mood changed, and he talked about the wild bees, native orchids, and the rare wood ibis he had seen in a nearby marsh. Yes, I am sure Orion's paradoxical life has deepened the lines in his friendly face.

At first it was just called the Conservation Symposium, but then someone hung a big sign, "South Carolina in Crisis," behind the speaker's rostrum, primarily for the press photographers and television. So everyone began calling it the "Conservation Symposium South Carolina in Crisis." Those who attended the symposium were an odd mixture, ranging from dedicated young scientists to unscrupulous freeloaders who had whiffed a chance to live high on the Hilton Head hog. If the participants had to be summed up, most would have to be called second and third rank, the lieutenants of the conservation and academic worlds. The big names, the Commoners, the Odums, the Browers, did not show. Yet for such short notice, Orion Hack managed to scrape up a fairly impressive crowd of people willing to spend several expense-free days at the Port Royal Plantation Inn.

It was evident from the wide range of attitudes and platitudes that the group was too large and too diffuse to accomplish anything, so the symposium broke up into three subcommittees: scientific, economic, and citizen's action. These met separately, exchanged views on why the BASF complex would be harmful, and drew up reports with recommendations. The three reports were combined into a single document, which was released and read with some fanfare to the invited press and television representatives on the fourth and final day of the symposium.

The ten members of the scientific subcommittee arrived at the almost inevitable conclusion reached by scientists involved in a dynamic public issue: that preliminary studies were needed. They recommended a moratorium on all coastal construction, and that "detailed preliminary studies of at least two years' duration of the coastal ecosystem, involving hydrographic, biological, chemical, and physical investigations, be conducted. . . ." The recommendations of the other subcommittees were similarly weak.

The scientists' cry for more studies is often a shirking of responsibility, a refusal to take a firm stand. It reflects the weakness and uncertainty of their knowledge, as well as their inability to handle broad problems.

I am convinced that every scientist at the symposium knew intuitively, if not scientifically, that the chemical complex would destroy the natural ecosystem of the area. Yet the strongest stand they could take was to call for preliminary studies and a moratorium. I am further convinced that most of

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the scientists, especially the bright, young ones, felt certain that their call for a moratorium on construction would be ignored and that the BASF complex would be built.

At a press conference on the final day, one representative of the local scientific establishment did take a stand, to the chagrin of many who were present.

By the time Roger Pinckney, civil engineer, marine contractor and county coroner, was halfway through his lengthy harangue, several people were wishing there was a trapdoor that could be sprung behind the podium.

Waving two U.S. Coast Guard charts to support his claims, Pinckney declared that he was only presenting the facts, and "let the charges fall where they will."

The crux of Pinckney's long pitch was that dredging a channel to the Colleton River would destroy the freshwater aquifer of the region. "Ladies and gentlemen, you won't drink water any more, you'll have to drink bourbon or something else.

"You will never make a deep channel out of Port Royal Sound. The Lord didn't intend it that way. I challenge any man to deny what I've said and to tell me I'm wrong," he concluded triumphantly.

Most of the scientists at the symposium missed the county coroner's performance because they had already returned to their universities and research institutes. One who remained for the press conference was Dr. Herbert L. Windom, a marine chemist at the Skidaway Institute of Oceanography in Georgia. Dr. Windom judiciously presented the scientific subcommittee's report and listened politely to Pinckney's speech. He maintained a decorum that makes even more surprising the vituperative political charges that were subsequently leveled against him.

Two weeks earlier Windom had become indirectly involved in the BASF dispute when he and Dr. Fred Marland, a marine ecologist from the University of Georgia, examined an estuary near a small, two-year-old dye plant of Tenneco Chemicals, in Beaufort County. They had been asked to do so by the owner of the adjacent land.

Windom and Marland found an

ecosystem devastated by pollution. The salt marsh grass was discolored and dying. All the mussels and many oysters were dead. Windom measured the pH near the sewage outfall of the Tenneco plant, and found that it ranged from 1.5 to 2.5, in contrast to the 7.7 pH reading in a nearby unpolluted area. He found excessive traces of metal and a lack of oxygen in the waters near the plant.

Although the Tenneco plant has no direct connection with BASF's plans for a much larger dye and pigments plant, the scientists' findings highlighted the dangers of pollution from a new plant and revealed the ineffectiveness of the state's Pollution Control Authority. Before the Tenneco plant was built, Tenneco spokesmen and the executive director of the Authority had assured county legislators that there would be no pollution.

Dr. Windom's investigation of the pollution around the Tenneco plant and his role in the symposium must have touched some sensitive nerves because it caused the usually smooth Gov. Robert E. McNair to lose his cool. Two days after the symposium the Charleston *News and Courier* had run a banner headline exclaiming, "Chemist Should Remain in Georgia, Says McNair." The governor, reported the newspaper, said "that Dr. Windom would be better advised to stay in Georgia and help Gov. Lester C. Maddox correct the pollution problems in that state rather than come to South Carolina and tell this state what it should do about pollution." The paper noted that "Gov. McNair was extremely disturbed at Dr. Windom's remarks at the symposium."

"I'm really angry at the governor," said one of the South Carolina scientists who had been at the symposium. "He was unfair to Dr. Windom. The report at the symposium was from ten scientists, not just from Dr. Windom. I really feel I should do something about the governor's remarks." But he did not do anything, possibly because he has to live and work in Governor McNair's state.

The governor has been deeply involved in the wooing of BASF to South Carolina. He was at the formal announcement ceremony last October at BASF headquarters in Germany, and he has gone far to see that BASF officials have had the full hospitality and cooperation of the state.

He met with Charley Fraser and Fred Hack early in December in an effort to turn aside their objections to the BASF project. "I assured them," he announced, "that the State of South Carolina would live up to its responsibility in seeing that the environment of the area would not be changed by industry.

"We have assurances from BASF that the company is vitally concerned about the ecology and beauty of the area and that steps are being taken to satisfy all legal, environmental, and industrial requirements in safeguarding the air and water from pollutants." The governor made this assuring public statement two weeks before the Tenneco plant mess hit the headlines, which may explain his irritation with Windom, since governors do not like to have their foolish statements made to look foolish.

"What about the Tenneco plant?" I asked Clair Guess, the executive director of the South Carolina Water Resources Commission.

"Boy, they really blew the fuse on that one, didn't they," he replied, laughing but saying very little else on the subject.

Guess is the governor's top adviser on water problems. His commission has just completed an impressive 178-page "South Carolina Tidelands Report," which focuses on many of the problems of the coastal area and recommends sweeping legislative action. One of the findings of the two-year study is that fourteen state agencies and six federal agencies have interests or responsibilities, which often conflict, in the tidelands. This division of responsibilities makes over-all planning and broad-scale environmental protection impossible.

In a move that seemed timed to counteract the effects of the conservation symposium, the governor requested Guess and his commission to "conduct a thorough study of the environmental and ecological conditions existing in the lower part of South Carolina, particularly that area around the proposed location of BASF."

Continued on page 64

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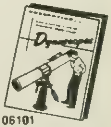

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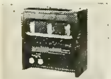

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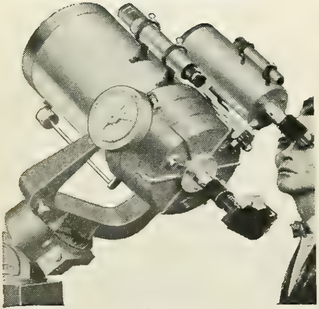

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A Naturalist at Large

A Student Manifesto on th

by Pennfield Jensen

The phenomenon of student activism is as much a barometer of global crises as it is a manifestation of personal frustration and organized disruption. The celebrated generation gap is little more than the naturally holistic consciousness of young people facing a way of life that is not only ugly, irrelevant, and neurotic but that threatens to destroy us all. The natural environment, on the other hand, presents to the sensually connected but culturally shocked young person the clear light of moral value and societal obligation. Earth: Love it or leave it.

The impatience demonstrated with the establishment is the best part of today's activism. The worst part is seldom seen for what it really is: a despairing apathy that stultifies all endeavor. The activist is basically a constructivist, a creative and productive person dedicated to "making it better" while, at the same time, demonstrating that the culture, the economics, and the politics of the United States are hopelessly antediluvian. It's not right. It's not working. Shut it down. The healthy concerns of today are directed toward the environment and reach beyond all national boundaries. For nationalism itself is a disease of the mind that settles over a country, smothering its intelligence under a blanket of rot thicker than the smog we breathe. When a young man's life becomes shattered by the blind trauma of a useless war or by the faceless sadism behind an official load of buckshot, one hears windows begin to break the world over. These are dead-ends. Ultimately, activism wants a big answer to a big question. We don't want merely to survive; we want to live. There is only one place to live and that is on this planet and we must live here together.

While individuals of stature and wisdom are arguing for an international ecological congress to establish laws for international use of the earth's resources, the ecological crisis has already precipitated student activism into one of the world's most potentially constructive forces. The activists do not struggle against educational systems because education is despised but because education is needed. The naïveté, enthusiasm, and idealism of young people is not a thing to be scorned; it is rather to be celebrated as the raw material of constructive growth.

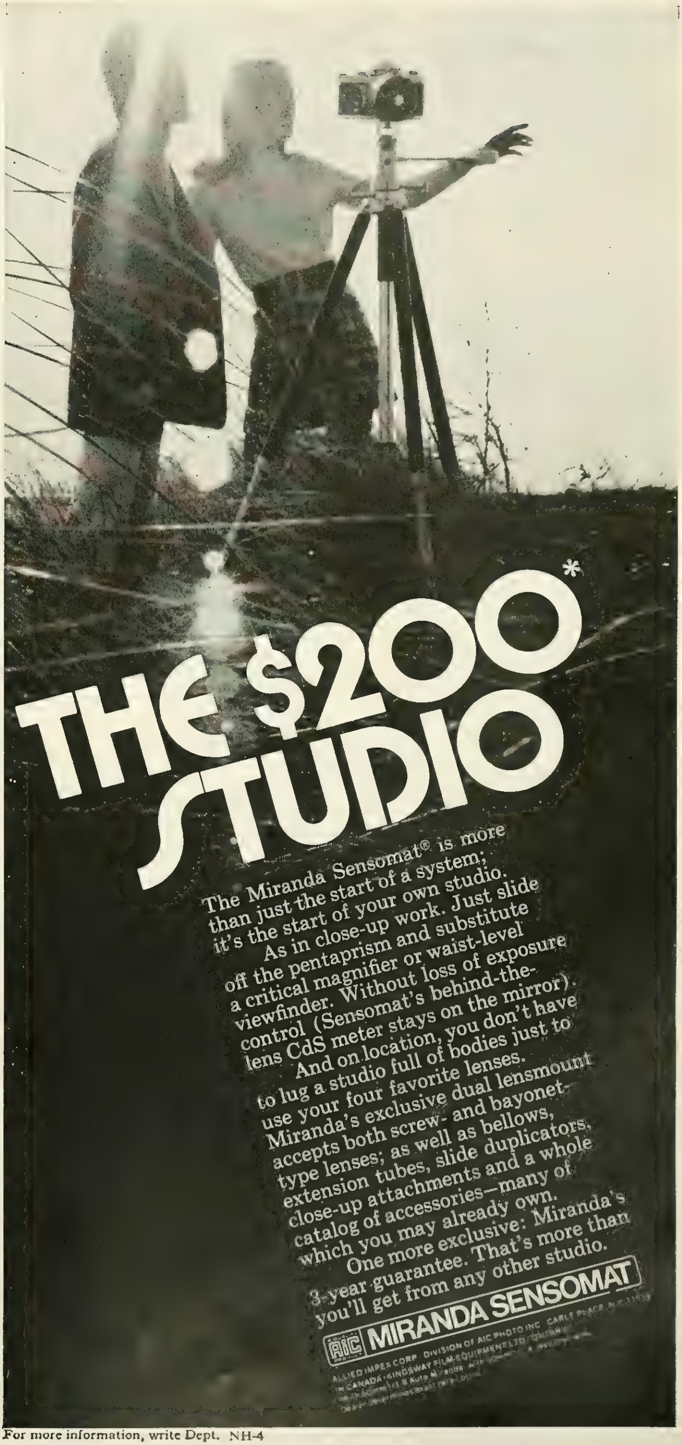
The ecological perspective shows all of life connected into dynamic processes with ineluctable consequences should those processes be changed.

The ecological sentence for mankind is: "Get with it or die."

nvironment

In the meantime society is asking its young people to be satisfied with what they have, believe in the American Dream, and accept the heritage of genocide and pollution with pride, patriotism, and purpose. In short, we are asked to volunteer our suicides, and to do so quietly without disturbing the peace of our retiring benefactors, the over-40 generation. America was given the greatest single miracle of natural creation ever bestowed upon any civilization, but the gallery of "Great Americans" who so utterly and systematically destroyed it is a morgue celebrating the perpetuation of our fantasies of greed and power.

The consequence of genocide cannot be pardoned. The participants in that genocide cannot be excused. We do not look upon industries, churches, developers, businessmen, and politicians as being necessarily bad; we simply see them as our executioners. I am not going to befriend my executioner. I am not going to dedicate my talent and intelligence to his irresponsibility. I am going to dedicate myself to the only element that predicates our survival and the survival of our children on down to the 10^{19} power: the stable ecology of this planet. Whatever stands in front of that goal will be destroyed. If it is the church, we will shun its halls.



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If it is the school, we will shut it down. If it is the bulldozers of the profit-mad conglomerates, troop trains to corrupt wars, insane commercial gluttony or the logging trucks of our paper-tiger economy that need stopping, then we will stop them. We will stop the destruction of this planet even at the cost of our own futures, careers, and blood. The situation is simply like that. If you are not going to live for the earth, what are you going to live for?

As a species we continue to commute, pollute, and salute in righteous arrogance the despoiled flag of our environment. This cannot and will not be tolerated any longer. The irony, and I hope it never becomes the tragic kind, is that never before has mankind had the tools for self-perception and global understanding that are available to it today. This statement does not, however, place the argument in the hands of the technocrats of the space-race, the bomb-now-and-study-later school of scientific panaceas, for this is surely a pitiful travesty on the true role of science in the play called "Mankind." Rather, science has given us an understanding of the evolutionary play in the ecological theater and has awakened us to a true and challenging comprehension of man and of man's place on this planet. The future, in spite of its grim portent, is the greatest hope and the greatest challenge any life form has ever had. Let it be clear, though, that the great blight of human overpopulation is the problem of success, and let us further beware lest our epitaph read: *Here lies a species that failed only because it succeeded too well.*

The misapprehension of the motives and intentions of today's young activists comes from a larger misapprehension of the age in which we live. The inner yearnings of nearly all young people are for a simple and enriching life. Coupled with the problem of global survival is the much more personal crisis of emotional survival. The cities stink. The rivers are polluted. There is no way to make an honest buck. The goal of most young people is self-realization: riddance from neuroses, anxieties, and guilt. In short, people are seeking and expressing their freedom. It is the crowning achievement of democratic culture; it is for the most part a tremendously healthy thing. The unhealthy things are catchwords in this era: alienated, freaked-out, hung-up, and others, and take their significance with respect to whichever side of the "gap" you happen to be on.

The second part of this urge to emotional wholeness and survival takes the form of a large-scale exodus from the cities to the country, but this cannot last either: there simply isn't enough country. The consequences of this step-by-step introduction to the spiritual, emotional, and physical nourishment of the undeveloped, ecologically whole countryside will be an ever greater demand for access to our natural areas, for more natural areas, and for the information, sustenance, and peace they provide. The ecological perspective provides a picture of life that focuses on a miracle of creation and evolution that is wonderful, brutal, and inspiring.

Where, one may ask, is the activism of youth heading? It is certain that the ecological perspective and the reality of the ecological crisis will mature the destructive and volatile naïveté of the young leftist. The "hashish dreams of guerrilla warfare" based on lineal Marxist pollutionist dogma are a tunnel vision to a sign reading "no exit." The real revolution is the one already under way on global food chains and on our as yet unborn.

The constructive nature of student involvement with the issues stemming from environmental awareness is emphasized in the demands of the following manifesto composed by the youth delegates to a recent conference.

On a national scale, we urge:

- *The mobilization of the national effort to attain stability of numbers, and equilibrium between man and nature,* by a specified date, *with the attainment of this goal to be the guide for local and national policy in the intervening years;*
- *The immediate assumption of a massive, federally financed study to determine the optimum carrying capacity of our country, on the community, city, county, state, and national levels, with this carrying capacity to be predicated on the quality of life, the impact upon world resources, and the tolerance of natural systems;*
- *The adoption of new measures of national well-being, incorporating indices other than the rate of growth of the gross national product, the consumption of energy resources, and international credit ratings;*
- *The immediate rejection of international economic competition as valid grounds for the creation of national policy.*

On an international scale, we endorse:

- *The proposal that the leaders of all nations through the United Nations General Assembly declare that a state of environmental emergency exists on the planet earth;*
- *The creation of colleges of human ecology and survival sciences in the member nations of the United Nations;*
- *The creation of national, regional, and global plans for the determination of optimum population levels and distribution patterns;*
- *The creation of national, regional, and worldwide commissions on environmental deterioration and rehabilitation;*
- *The proposal that the United Nations General Assembly adopt a covenant of ecological rights similar to the U.N. covenant of human rights.*

Within the changing fabric of activism itself, there is a great role yet to be played by the conservationists. It is to these people that the maturing young are going to look for help, education, and leadership. It is truly to "the men of the earth," to the men of global understanding and international commitment, that the reins of world leadership will be handed. This is the one area where the cooperation of all sides can be gained and the only area where the power structure can communicate and join forces with today's enthusiastic young activists. Without this coming together over the common goals of a quality environment and a stable ecology, we will continue to suffer the ravages of confrontation and disruption only to reap the grim harvest of irredeemable waste of energy, intelligence, and human life.

This "Student Manifesto on the Environment" is a warning . . . but more than that, it is a supplication.

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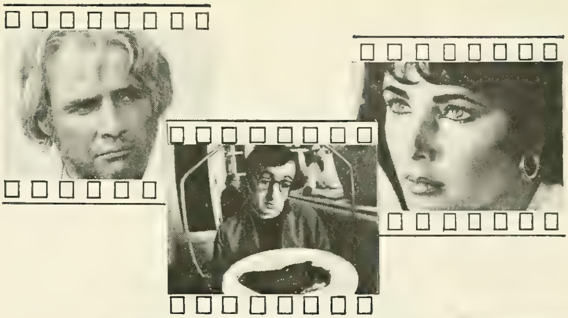

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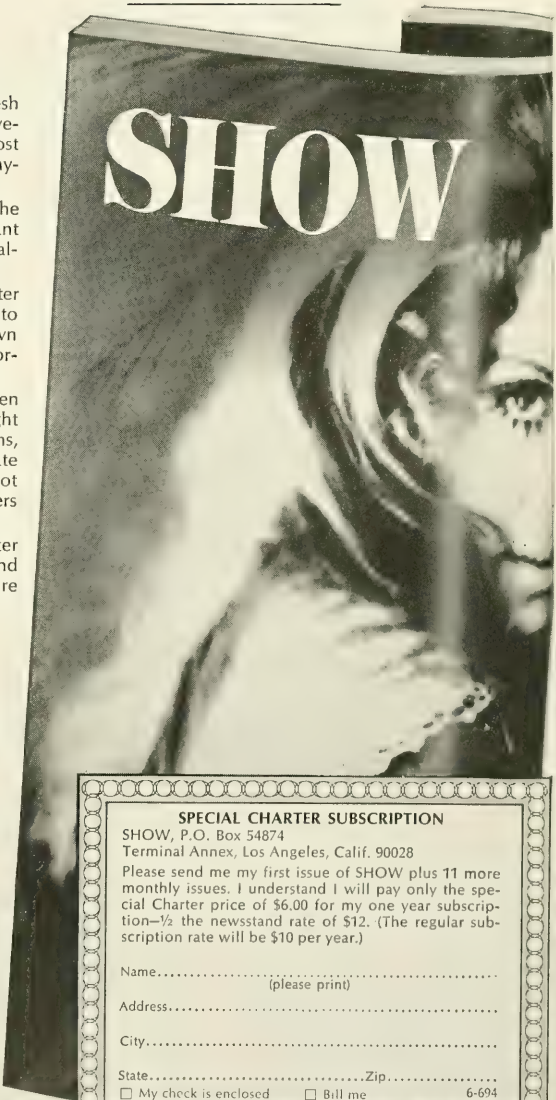

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EAST IS A BIG

"To imagine Puluwat without the élan of its seafaring life one must think
can remind men they are men, the canoes that Puluwatans build, and
not just its men, with a sense of purpose and fulfillment."

Puluwat is an island of green, edged in white and set in a tropic sea. Already distant, a canoe is sailing away. Its sail accents the scene, a white cockade bobbing over the waves, impudent and alone.

Then the canoe and its crew are gone. In the days or weeks thereafter no one on Puluwat can know where they are. Finally someone, perhaps high in a tree picking breadfruit, sees a tiny white triangle on the horizon and emits a whoop. The cry is carried from voice to voice, and within a minute everyone on Puluwat knows a canoe is coming. More men climb trees, and soon eyes practiced in the scrutiny of sea and sails distinguish a familiar mark or shape. The canoe is identified. The studied indifference of those left behind gives way to excitement. If the journey has been long and the day is pleasant, the lagoon will fill with canoes paddled out to greet the travelers as they enter the pass in the reef. The voyage is over. All of Puluwat shares in the reaffirmation of a proud heritage.

From the canoe, the perspective is quite different. Anyone who has sailed a small boat in the open sea need not be told that the image of a little sail bobbing over the water would scarcely come to the minds of those on board. The sail dominates them not only by its size, but by its tense struggle to contain the wind it has deflected to its own use. Vibrating, it strains at its lashings. Alternately the sail shades the crew or blinds them with its whiteness. The spars sway and shudder as the boat lifts and plunges through the steep waves of the open Pacific. The canoe itself, a narrow V-shaped hull about 26 feet long, with platforms extending out both sides, lurches with a violence that requires constant holding on. If the crew is lucky and the wind holds steady, this pitching and twisting will go on, without rest, day and night for the day or two or three it takes to reach their destination. But the wind may drop and leave the crew drifting under an equatorial sun. Or it may rise to a storm with gusts wracking the canoe and driving chilling rain into the skin and eyes of the crew. Through all of this the navigator, in sole command, keeps track of course, drift, and position, guided only by stars and waves and other signs of the sea, and in recent years by a large but unlighted compass. Even at night he stays awake and vigilant, trusting only himself. They say you can tell the experienced navigators by their bloodshot eyes.

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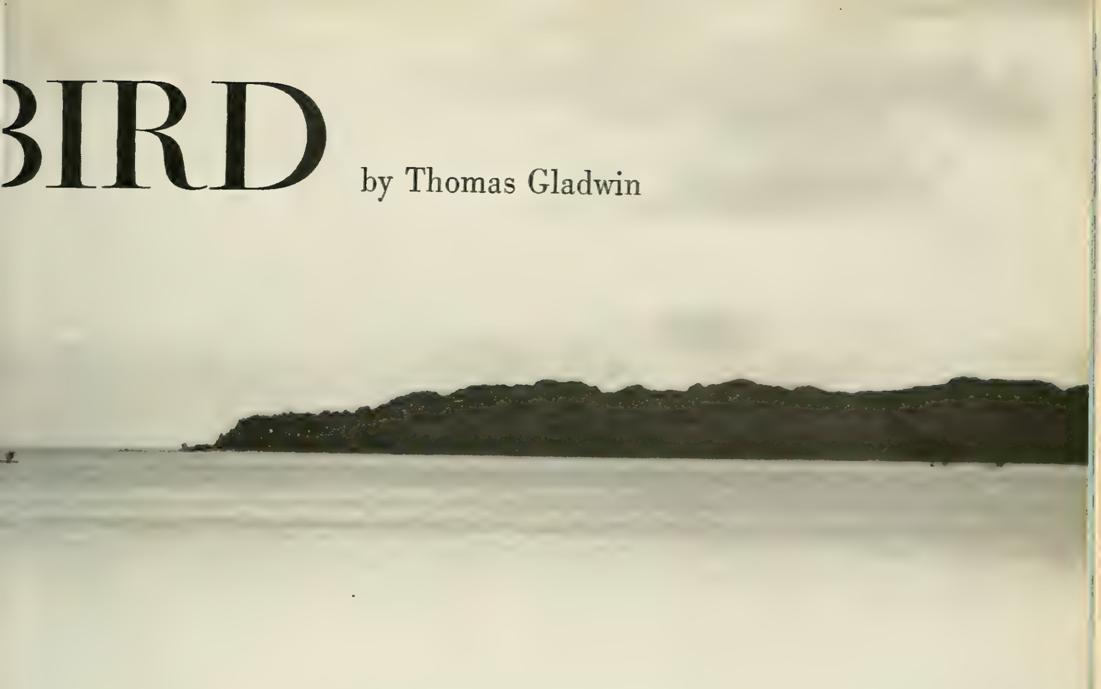
BIRD

by Thomas Gladwin



irited people. While the exhilaration of trolling over the reefs
ages that they undertake to distant islands, suffuse the entire island,

There is a heroic quality to this kind of sailing. Happily, everyone on Puluwat and the other islands of their seafaring world agrees as to its heroism. Even more happily, virtually every man, every child, and any woman who cares to can experience again and again the life of a hero. It is thus a hospitable sort of heroism despite its frequent hardships. Sailing canoes are complex and temperamental craft, but manageable enough for anyone brought up on them to qualify as crew. One is therefore not faced with a fear of failure. True, only a few achieve the skills of the navigator, but you do not have to be a navigator to be a hero.

Voyaging is hospitable, too, because, unless there is some occasion for worry, or bad weather is making everyone miserable, the prevailing mood at sea is one of good fellowship. Jokes find an audience eager for amusement, tales can be embellished endlessly without fear of losing listeners, and on most trips there is food to eat any time one becomes even a little hungry. There are discomforts, of course, and also risks. Without them there would be no zest, and no occasion for heroes. But the discomforts are transitory and, when you are used to them, quite tolerable. The risks are real, but not nearly as great as one would expect contemplating the vast stretches of ocean, the tiny slivers of wood and cord that are a canoe, and the little dots of land that are the islands to which Puluwatans sail. The reason the risks are not greater lies in the realm of technology. It lies in canoes, which may look complicated and sometimes crude, but that are extraordinarily tough and versatile in the responses they can make to all manner of conditions and crises. It lies in a system of navigation that, in the hands and eyes of a gifted and vigilant navigator, covers just about every contingency. But above all it lies in the skill and resourcefulness of a people born to the sea and proud of its mastery.

Puluwat is one of a long chain of low coral islands that lie between volcanic Truk on the east and Palau and Yap on the west. Taken all together, these islands comprise the Western and Central Carolines; they cover more than a thousand miles of the Pacific Ocean north of New Guinea. The low islands, from Puluwat and its neighbors westward to Sonsorol, southwest of Palau, share a similar culture and languages. They are closely related to Truk, but differ sharply from Yap and Palau.

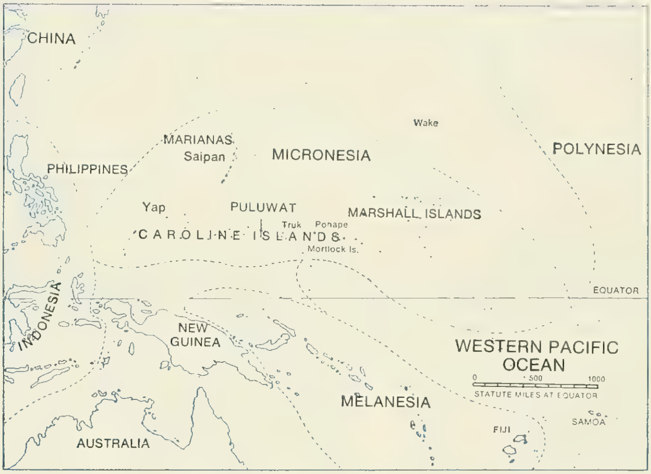
In recent centuries the Carolines have been controlled successively by Spain, Germany, Japan, and the United States. Through most of this time. however. Puluwat was little influenced. Explorers, traders, missionaries, and administrators remained on the island only occasionally and temporarily. During World War II the Puluwatans were evacuated by the Japanese to nearby Pulusuk for military reasons, but after the war they returned to take up a life little different from before. Only the Americans have tried to bring about radical change, principally through education, Christian missions, and indoctrination of leaders. Although these have had some impact, thus far one is struck more by how little has changed than by how much.

Beyond Puluwat lies a world of little islands, some inhabited and some not, but each with its own special shape and nature, and each in its own assigned place upon the vast surface of the sea. As one thinks of these islands, one over there, another there to the north, a third over here closer, the sea itself is transformed. No longer is it simply a great body of water that, encountering Puluwat, shoves around it and re-forms on the other side to flow on to an empty eternity. Instead the ocean becomes a thoroughfare over which one can think of oneself moving toward a particular island of destination, which as one comes upon it will be waiting, as it always waits, right where it is supposed to be. When a Puluwatan speaks of the ocean the words he uses refer, not to an amorphous expanse of water, but rather to the assemblage of seaways that lie between the various islands. Together these seaways constitute the ocean he knows and understands. Seen in this way Puluwat ceases to be a solitary spot of dry land; it takes its place in a familiar constellation of islands linked together by pathways on the ocean.

The Puluwatan pictures himself and his island in his part of the ocean much as we might locate ourselves upon a road map. On a road map, places—mostly communities —appear as locations with names, linked by lines of travel. Those we know from having visited them spring to mind: the buildings, the people, the spirit of the place. Those we know only at secondhand have a less clear image, and some are nothing but names. But each has its place, and there is a way to get to each one. Each has its part to play in the totality, which is a state or region or country. So it is with the island world of the Puluwatan. He knows of many islands and can visualize where they are and how to get to them. Some he has visited; he knows people and places on them that set them apart. Others he has heard about because people from them have visited Puluwat, and Puluwatans have traveled the seaway there on their canoes. Still other, more distant islands are spoken of only by their names and legends. While the navigators know the star courses to them. they have never traveled these courses—but they know that if they did, the islands would be there.

Historically it was essential that Puluwat be a part of this larger island world. It would never have developed as it has if it stood alone.

Puluwat canoes glide over gentle swells in the open ocean. Usually they travel alone, but company means added safety.



ozens of islands stretched over a ousand miles of ocean from Yap . the west to Truk and the islands yond on the east have been ıked by their seafaring men and eir sailing canoes into a network social, economic, and often polit- ıl ties without which they prob- ly could not have survived, much s evolved the complex and secure ıy of life they now enjoy. The op- rtunity to exchange people, goods, d information permits these tiny mmunities to survive disasters—tably typhoons—to draw from a ol of ideas and innovations larger ın just their own, to integrate ıen useful into larger political oupings, and to extend the range choice in marriage beyond the ıited number of unrelated part- rs available on one's own island.

These are all highly practical, in- ed essential, considerations. Yet yond its practical value, the sea- ing life, the constant voyaging sailing canoes back and forth tween islands, has acquired a ychological worth of its own. It ds a measure of meaning and lue to every other act, on land as ll as at sea. Nothing could attest this more eloquently than a radox: as the seafaring culture Puluwat renews itself with un- ninished vitality—building new ıoes, training young navigators, perimenting with novel tech- ques—the practical necessity for ıas all but disappeared. Virtually of the exchanges of people and ngs and ideas outlined above ıld be achieved reasonably well ough travel on small passenger- rying ships, which have been king regular administrative and ding trips through these islands the past twenty years.

The Puluwatans approach fishing much the same way. Seine nets, ıdlines, and spearfishing are of- more productive, but Puluwa- s prefer trolling over the outer fs at high speed, chasing the eeling seabirds that signal school- fish below. The canoes take beating—rougher treatment and re risks than would be acceptable a long ocean voyage. But fishing part of what the canoes are built , and as all the canoes strain toward a school of fish, you know at once which sails the best and which captain is most skilled and daring. This is the good way, the proud way to catch fish.

The truth of the matter is that the Puluwatans are not objective about their canoes, even less objective perhaps than we in the United States are about our automobiles. Especially for those of us who live in cities, the minor inconvenience of public transportation should weigh far less in the balance than the cost and trouble of keeping a car, yet most of us not only keep our cars but at intervals buy new ones. We say the automobile has become part of our way of life and we do not want to give it up. On Puluwat the sailing canoe is not merely a part of their way of life, it is the very heart of it. To suggest that the Puluwatans should beach their canoes and retire their navigators would be to foretell disaster. To imagine Puluwat without the élan of its seafaring life one must think of a dispirited people. While the exhilaration of trolling over the reefs can remind men they are men, the canoes that Puluwatans build, and the voyages that they undertake to distant islands, suffuse the entire island, not just its men, with a sense of purpose and fulfillment. In the last analysis everything on Puluwat is justified by the contribution it makes to the capability of boats and people to travel well and safely at sea.

There is no sign that this enthusiasm is waning. If anything, it is growing stronger. The rest of the world may see virtue in mechanization, in power and efficiency, but on Puluwat almost every young man still aspires to become a navigator. Only a handful make it, but those who fall by the wayside are willing to settle for the lesser glory of being a crew member on a Puluwat canoe. Thus far very few young people appear inclined to leave Puluwat to seek their futures in the district center on Truk or elsewhere. Rather, the young men are learning to build, to sail, and hopefully even to navigate canoes, and young women are readying themselves to be wives of seafarers.

In the Carolines there are good seasons for sailing, and bad. The Puluwatan navigator knows these times by the rising and setting of certain stars just before dawn or at dusk through the cycle of each year. He knows the weather and winds associated with each of these star months and can thus forecast the seasonal changes.

In April atmospheric pressure from the north weakens, the doldrum belt begins to move north toward the equator, and the trade winds, although still blowing fairly steadily from the northeast, drop in strength to comfortable levels. The sailing canoes have been overhauled, and one after another, or in convoys of two or three, they set off on their various journeys.

During July and August the doldrum belt has moved so far north that Puluwat lies south of it. Now the trade winds are coming from the south. Although below the equator the trades typically blow from the southeast, when they cross the equator the same winds turn and come from the southwest. This more westerly wind is fine for voyages to the east. With a southwesterly breeze one can go to Pisaras, East Fayu, or the Halls with the wind astern, and thereafter run down to Truk itself with the same wind comfortably on the beam. Then wait a week or two and the wind will often shift around to blow you home again.

Linger too long, however, and the doldrum belt will have passed again to the south. This usually happens toward the end of September. Cooler air from the north comes upon water heated by the summer sun and doldrum winds, and the mix becomes unstable. This is the season of typhoons, identical to the hurricanes that are spawning at the same time and for the same reasons in the Caribbean and adjacent Atlantic waters. These storms come up so fast and with such fury that only the most daring, or perhaps foolhardy, of navigators will venture on a long trip during late September or October. After this the weather stabilizes again, the northeast trades (which actually vary between northeast and east) dominate, and canoes that were caught on Truk can return home to Puluwat with a good wind behind them. Gradually the winds grow in strength, with an occasional letup near the end of December, until the steady, discouraging blow of the drab winter months sets in and everyone stays home to await liberation by the gentler weather of spring.

The intention to make a long trip, such as one to Truk or Satawal, usually develops over a period of several weeks or more. This is not always true, however. If, for example, a canoe is long overdue, worried relatives on Puluwat may decide overnight to set off on a search for them and leave within a few hours. Stops are then made at all the islands, however distant, which the missing craft had planned to visit, plus any others along the way, to learn whether the canoe was sighted and when.

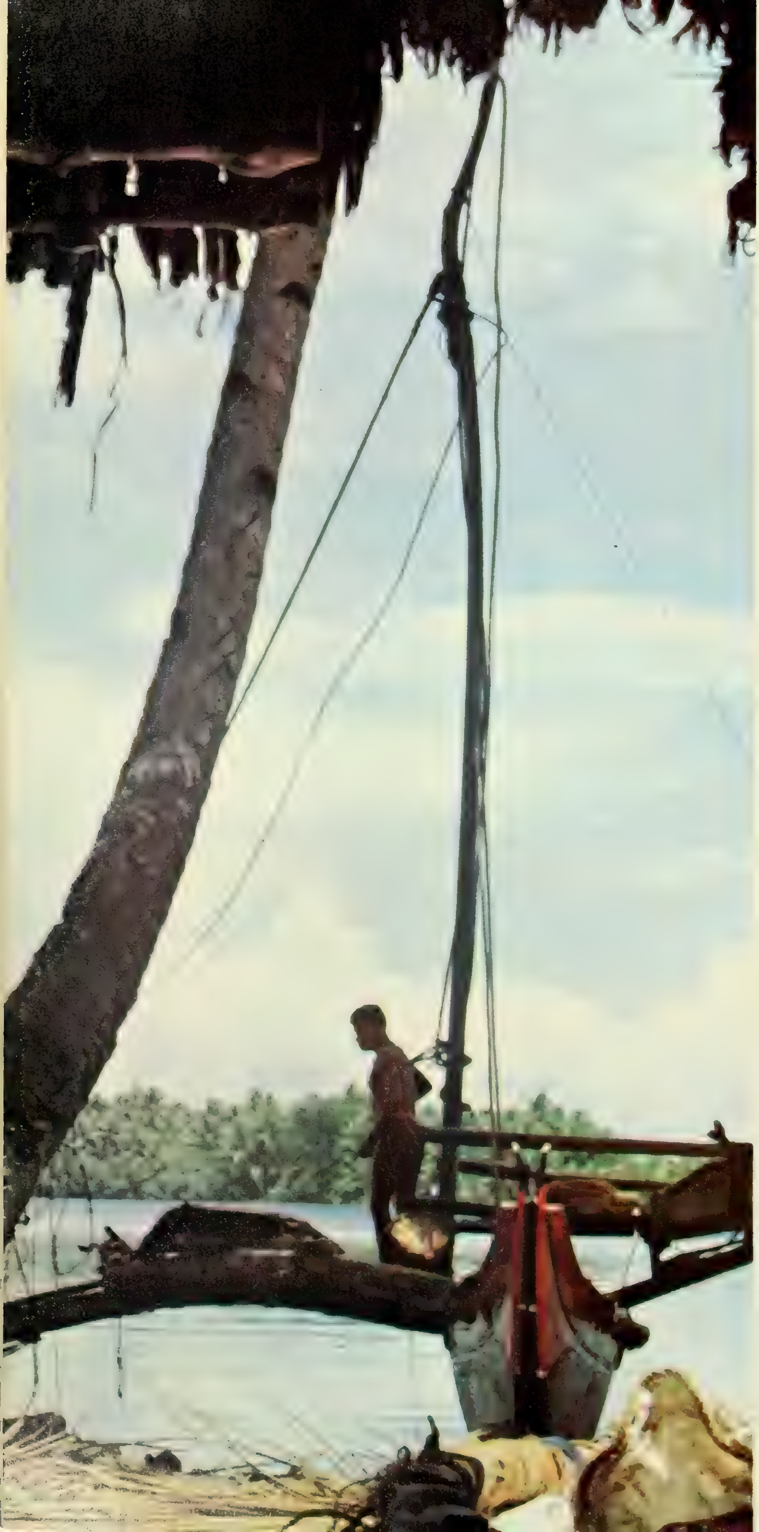
The actual decision on when to leave, however, is usually reached only two or three days, never more than a week, in advance. If the question is pressed, one is told this short lead time is necessary in order to be able to forecast favorable weather during the first leg of the trip. However, the weather forecasting system operates essentially as an almanac dependent upon the rising and setting of stars and the phases of the moon. The Puluwatans know quite enough about these matters to forecast the positions of the heavenly bodies weeks ahead, but the final decision of whether to leave on the appointed day is determined by the look of sky and sea at the time.

Preparation for a voyage begins with rounding up a crew. Four to six men comprise a full complement. Most of them are likely to be members of the navigator-captain's canoe house or co-owners of the boat or both. Although a core group of men seems to travel regularly on each canoe, there is nothing rigid about this. The canoes are sufficiently alike that no technical problems arise from riding on an unfamiliar craft, and there are no special loyalties associated with individual canoes. The word soon gets around that so-and-so is making a trip to Truk or Ulul or Satawal. Anyone who is waiting for a chance to go there can be fairly sure of finding a place on the canoe just by asking. The navigator presumably intends to round out his crew with some of his younger relatives whose services he can virtually command, so he easily makes a place for the petitioner by dropping one of these. He must also, if possible, include in his crew at least one other man with navigational skills in case he is himself incapacitated.

Crew members strain to refloat their canoe after turtle hunting on Pikelot. They lift up, as well as push, to minimize damage to the bottom of the hull.

If women or children are coming along, it is necessary to install a small, domed cover of plaited pandanus leaves over the lee platform. This little cabin is usually carried on any long voyage since under these circumstances there will probably be a good number of trade goods, gifts, and personal effects, which should be kept dry, and the shelter is welcome too for sleeping if the weather turns wet and cold. Women and children require more, however, than food and shelter. There must also be a man in the crew who is responsible at all times for each passenger. For women this is almost invariably their husbands. Particularly in the old days when it was believed that women posed a supernatural threat to the rest of the voyagers, it was essential that someone be available to assist them with any of the bodily needs that emphasized their femaleness. One could scarcely ask anyone but a husband to scoop up seawater time after time for a bath, so that as the woman poured the water over herself the sound of it striking the sea below would mask the noise of her urination. Even today, although the threat is gone, embarrassment is still possible when one or two women live with a group of men for several days on a very small boat. In these circumstances the only really appropriate intermediary is a woman's husband.

Children require even more attention. Despite the objections of their worried mothers, boys and girls are often taken on their first canoe trip to another island when they are only five, or sometimes even four years old, so that, early in their lives, they will get to know

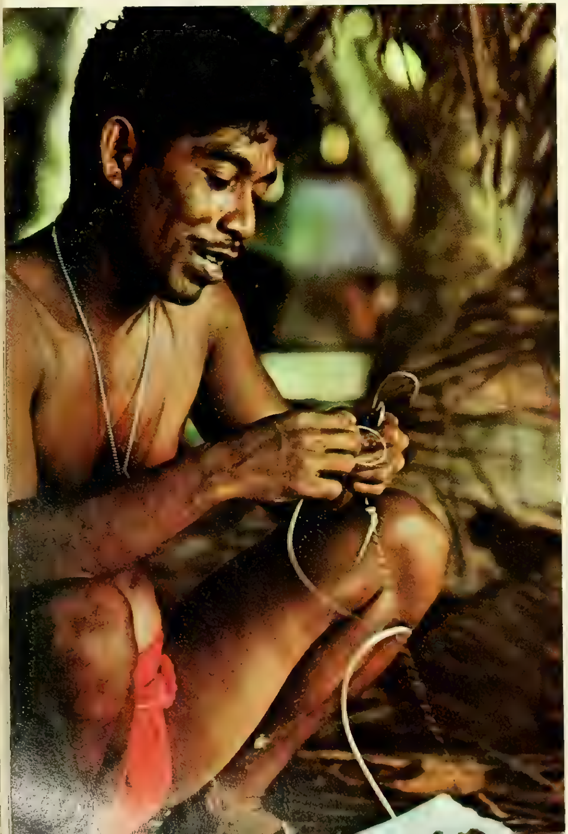


Extremely narrow hull of an oceangoing canoe is balanced by outrigger, extending out to the left, and lee platform, right.

and to enjoy life at sea. To this end they are allowed the run of the boat, not cooped up in the little cabin except in bad weather. Thus, in addition to seeing that they are fed and that their other physical needs are cared for, someone must watch little children all the time. They can swim—Puluwat children swim almost as soon as they can toddle to the water—but falling overboard can still be very dangerous, especially at night. Therefore, for any child aboard there must also be two men, relatives of the child, who will be responsible for him. If there were only one he would spend all his time watching his charge and fail to do his share of the rigging, bailing, fishing, and other seagoing chores. Nor would he be able to take a nap, even when the child slept, lest the latter wake up and fall overboard. These and other considerations frequently require a little juggling of the roster before the list of crew and passengers is firmly established, but it is usually possible to please everyone—and those who might be unhappy because they have been unceremoniously pushed aside are likely to be young relatives of the navigator who made the decision, and therefore may not appropriately voice any public complaint.

As the morning wears on, the

A master builder shapes the keel piece, which determines the dimensions of the finished hull.



Unlike their counterparts on Truk, 150 miles to the east, Puluwat children fear no one, not even strangers of another race.

boat is gradually loaded with equipment and supplies. With everything carefully stowed the outline of the canoe does not change markedly, but the boat settles in the shallow water and is moved out a little way. Finally, all is ready and the sail, wrapped in loose folds over its spars, is carried out. When folded together, the boom and yard to which the sail is secured do not match in their respective curves, giving a clumsy appearance to the long bundle of wood and cloth. This clumsiness will vanish once the sail is raised. Then these same curves create the graceful, piquant sail profile that is the hallmark of canoes in the Central Carolines.

With the sail aboard there is a pause. The crew comes ashore and may share a cigarette or two, passed from hand to hand among themselves and the well-wishers who will remain behind. Often before a longer trip everyone goes to church for a prayer and a blessing. In a touching gesture, the navigator may go to ask his old navigation instructor's last-minute advice if the mentor cannot physically lend his presence to the departure. Then, without any formal farewells, the men wade out through the shallow water to the canoe. If women are going along, they board first, settling themselves as best they can in the cramped space under the cover of the lee platform. The line or lines that hold the boat are untied and someone shoves it away from shore. As one or two men start paddling, the others get ready to hoist the sail. Those on shore watch as the canoe moves away and then drift off in twos and threes about their various affairs. By the time it is out of sight no one is left in front of the canoe house to watch, except perhaps some old people who have neither an excuse nor the energy to move elsewhere for a while.

Coming up to the wide pass, bounded on one side by the southern tip of Puluwat and on the other by a tiny islet that is the roosting place of at least a thousand seabirds, the canoe quickens to the motion of the sea. Inside the lagoon it has been gliding along unperturbed by the rippling water. Now after scarcely a moment of transition it is plunging and rearing through waves flung high as they breast the current, which most of the time swirls powerfully outward over the reef. Outside, the canoes settles down a little, but a narrow 26-foot hull, even though balanced by an outrigger, has no chance to stay still while moving through the labyrinth of massive waves that march and countermarch across the western Pacific.

Once in the open the navigator establishes his strategy for the first leg of his trip. He sets his course, tests the wind, and often calls for further adjustments of mast or sail. Perhaps he tells someone to move aft so his weight will sink that end of the canoe deeper in the water and thus improve its trim when the wind is on the beam. Only after he is at sea does the navigator determine his sailing plan and make his final adjustments. Before they left he doubtless noted the general weather and wind so that he had some idea how rough it would be and whether they would tack or run before the wind, but if the weather were not such as to create undue risks, he paid it little further heed. The sailing directions learned during the years of his apprenticeship are sufficiently complete to guide him in executing the voyage under almost all possible conditions. Beyond these general directions individual judgments must be attuned to the conditions actually observed at sea—seen with the eye, felt with the motion of the boat, and heard in the sound of the wind—conditions that cannot be inferred while standing on unyielding land with the wind blowing at full force only in the treetops.

Soon the canoe is well out at sea, settled on its initial course. The crew can relax. A line or two may be rigged for trolling, but only if there are reefs below teeming with fish or if the trip is short. A trolling line creates drag, which on a longer trip can slow a canoe enough that it may not make its landing at a distant island before dark. Like all good sailors, Puluwatans are constantly concerned with getting the last ounce of performance from any boat they are on. The rigging and trim are continually readjusted, and even the sand is omitted from the iron cooking box to save weight on a long voyage. Every extra pound makes the canoe ride lower and thus slower in the water.

As the journey goes forward anyone is free to make a suggestion about the course the canoe is on, the set of the mast, the look of the weather, or perhaps a detour over a reef to catch some fish. The navigator is in command, with all the authority and responsibility we are accustomed to associate with the role, but this does not set him apart, aloof from the rest of the crew. He joins in the jokes and gossip and talks about his navigation quite freely, especially if he has a son or other student navigator aboard who can learn from his example. If there is some cause for anxiety or question, the responsible navigator feels obligated to pay particular attention to the suggestions or doubts of his crew members. They in turn will not speak up unless they have some seniority and competence to back up their views. Examples of these inter-

Puluwat men weave rope from coir (coconut husk fiber) to barter for tobacco and imported goods on the next trip to Truk.

changes appear frequently in accounts of voyages told by navigators; it appears they are proud of their willingness to attend to these queries, rather than resenting those who question their judgment.

The routine at sea, unless there are storms, is relatively undemanding. At times everyone is talking; at other times, most are asleep—either stretched out, curled up, or propped against almost anything that offers support. No matter how crowded the canoe, people seem to find places to sleep without falling overboard. Occasionally, more often if the weather is rough, the canoe needs bailing. Someone sits on the little bench or thwart installed for this purpose down in the hull and throws the water over the lee side with a bailer, a scoop carved—like everything else—from breadfruit wood. All except the navigator take turns at this wearisome task without prodding or complaint. The crew members similarly relieve each other steering with the big steering paddle astern when this is made necessary by a following wind. Everyone is assumed to have the skill necessary to be a steersman, although it is soon obvious that some can hold a course better than others. Manning the sheet, which trims the sail and thereby trims the canoe, is more exacting. Sloppy work on the sheet can affect all aspects of the canoe's performance, as well as its safety. Most of the time the navigator tends it himself. When he wants relief he designates who shall take over. For a young man this can be an exciting responsibility, a rewarding gesture of confidence by the older navigator.

As with sleeping, so with eating. People eat when they feel like it. Usually one man gets out some food and the others join in. If fish have been caught, either they are eaten raw (especially tuna and bonito) or someone kindles a fire in the iron cooking box. It is set well aft on the outrigger platform so that sparks flying from the little, glowing heap of coconut husks will stream over the side. The fish are roasted whole on top of the fire and when they are done the fire is doused so that the husks can be used again, and also so that no more sparks will blow about.

Nowadays it is unusual for a canoe, if it does not run into some sort of trouble, to be at sea for more than four or five days, at most a week, at one stretch. In the past, trips were often longer, primarily because the canoes were slower and it took longer to get from one island to another. More distant journeys than are now customary were also made, but most of these were accomplished, as they still are, in stages, stopping at one island after another. A few, really long, unbroken voyages were made to more distant islands, islands large enough to minimize navigation problems in reaching them. They could be sighted over long distances and made large targets. These were islands such as Guam, Saipan, and Ponape. The men who made these heroic voyages were probably no better navigators than their modern counterparts, possibly even a little less accurate, but they were rugged and determined. They arrived at their destination half starved, dehydrated, and so burned by the sun they were black and almost poisoned by its effects. The return would not be made for months, and such trips were undertaken only rarely. Those recent enough to be remembered were made primarily to Saipan to trade with the Spaniards there for iron tools and knives, which could not be obtained in any other way. (Last year Hipour, a Puluwat navigator, using only his traditional knowledge, guided a modern ketch across 600 miles of open water to Saipan and then back again, making his return landfall unerringly on tiny Pikelot.)

Once the canoe has arrived, especially at an island where the crew have many friends and relatives, the welcome is warm and life is easy. No one need work. Their hosts feed them and entertain them with drink, good talk, and often at night a companion for their bed. If a man has not brought his wife along he can expect someone on the island who is his "brother," a relationship no less binding if it is artificial, to offer his own wife for the visitor's pleasure. Apparently not only do the visiting men appreciate this custom, but also the women. The wife who is offered in hospitality appreciates the novelty of a new sexual partner, and even the traveler's wife left at home understands and expects this sort of thing—as long as he does not try it once he is back on Puluwat! When such a warm welcome ashore is added to good fellowship and pride in their skill at sea, it is small wonder that men in return take lightly the risks and hardships of their long travels.

Finally the canoe comes home. In the past the men of the crew spent the first few days following their return living together without women in their canoe house. This ended with a small feast and ceremony in which they put behind them the world of the sea and formally returned to the island and to their families. Now, however, when the canoe has been unloaded and secured, or perhaps carried up into its place in the canoe house, the men disperse to their own houses to take up once again the lives of husbands and fathers.

Yet before long they will leave again on another trip, and another and another. Puluwat is a good island. It is a good place to be born, to grow strong, and even to die. Yet to discover its essence one cannot look only to the land. The land is only the backdrop and the place of preparation. Without its sailing canoes and seafaring men, Puluwat would have no past and no future. So with every voyage, and only through each voyage, its worth is renewed and its destiny fulfilled.

The second part of this article will appear in the next issue

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Small sailing canoes return across the lagoon after a day of fishing along the reefs in the open ocean.

Heart Poisons and the Monarch

As part of its defense mechanism the monarch butterfly (*Danaus plexippus*) stores heart poisons in its body tissues. These substances, known as cardenolides, or cardiac glycosides, are derived from milkweeds—common plants on which the butterfly feeds during its larval stage (**1**). The poisons are ingested by the caterpillar and carried through the pupal stage (**2**) to the adult (**3**).

If swallowed, cardenolides produce violent vomiting in certain bird predators such as crows and wood hoopoes. In this fashion the predator rids itself of the poison before absorbing enough to stop the heart. As a consequence, one such experience with the monarch—either at its caterpillar, pupal, or butterfly stage—has a lasting effect: the predator will thereafter give the insect a wide berth. Also, the monarch's bright colors—known as warning coloration—and its evocative scent serve as an *aide-mémoire* for future occasions should the bird meet this prey again.

The milkweeds (Asclepiadaceae), on which the monarch feeds, owe their name to the milky sap that exudes from the stem if it is broken or injured. While we were rearing the monarch we had occasion to pull some leaves off the main stem of one of the plants, resulting in a copious flow of creamy fluid down the stalk. Immediately, two of the monarch caterpillars in the vicinity abandoned the leaves on which they were feeding and advanced rapidly toward the stream of milky sap. Quickly imbibing the fluid, they finished every drop like a couple of thirsty cats (**1**). We repeated this experiment on many occasions, and in each case the caterpillars eagerly drank up the exuding sap.

Poisonous substances are not always found in equal concentrations in all parts of a plant. It is well known, for example, that the stems of rhubarb are edible while the seeds and the leaves are poisonous.

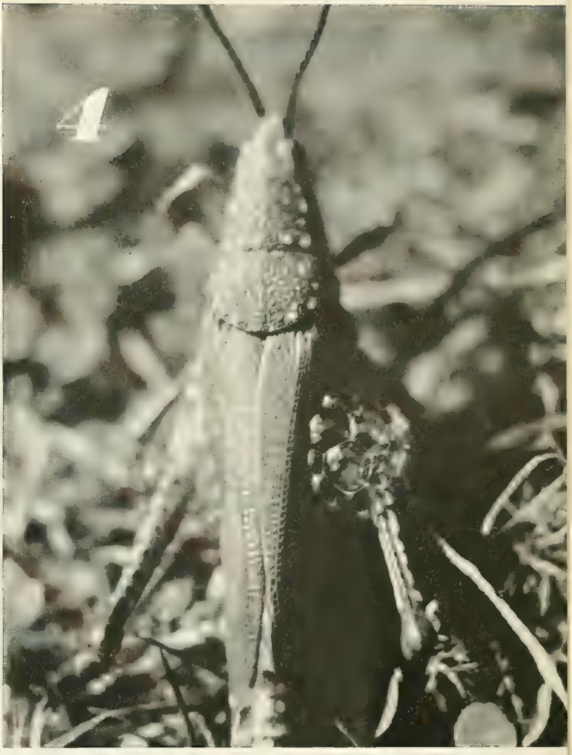
The point is illustrated by some experiments carried out recently in collaboration with Prof. Tadeus Reichstein. We reared a warningly colored, yellow greenfly, or aphid (*Aphis merii*), on *Asclepias curassavica*, the same plant from which our monarch caterpillars were lapping up the milk. These insects, although they feed on leaves and young shoots, insert their mouthparts directly into the sieve tubes and imbibe the tissue (phloem). When we analyzed the aph-

by
Miriam
Rothschild
and
Bob Ford

ids' body content it was found that they contained other cardenolides but not calactin, which is the chief heart poison found in the monarch. It seems likely therefore that the principal toxic elements stored by the monarch in its hemolymph and body tissues are derived from this plant's milky latex (which is particularly rich in calactin) upon which the greenfly apparently does not feed. Thus, having evolved the habit of sap-drinking, the caterpillars can rapidly increase their store of protective heart poisons.

Not all milkweeds contain cardenolides, and those that do may contain different sorts of heart poisons of varying toxicity. Thus the cardenolides found in *Asclepias syriaca,* a common food plant of the monarch in the United States, may not be as poisonous as those in *Asclepias curassavica,* and could well exert somewhat different effects on vertebrates. It is also possible that the monarch caterpillar, like the grasshopper *Poekilocerus bufonius* Klug is "hooked" on certain cardenolides. This grasshopper, which emits a poisonous foam(**4**) when it is disturbed or attacked, deliberately selects leaves that have been coated with calactin-rich latex, but it will not eat foxglove (*Digitalis*) from which we extract the cardenolide drug called digitalis, used extensively in the treatment of human heart disease. It is possible that the monarch caterpillar can discriminate between those plant species that contain the highest concentrations of these chemicals and can assess the quality as well as the quantity of heart poisons in their food plant. Some experiments are now in progress to investigate this aspect of their behavior.

Not all predators, or potential predators, of the monarch are sensitive to cardenolides. Mice, which are said to wreak havoc among hibernating hordes of this butterfly, eat them with impunity (**5**), and the Japanese quail (*Coturnix japonica*) appears more or less immune to the effects of these substances. In captivity this bird may eat the monarch, but not with enthusiasm. It can, however, swallow a dose of digitalis large enough to kill fifty men and apparently suffer no ill effects. This illustrates a very important principle: the protective devices evolved by animals are never absolute, for some predators invariably manage to keep pace with them.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BARNARD'S STAR: The

A nearby star is wobbling as it hurtles through space, a sure sign that it is accompanied by its own retinue of planets

by Peter van de Kamp

For eighteen long years—during which the earth was convulsed by World War II, the reign of nuclear terror started, and new nations began to proliferate around the globe—my staff and I patiently made thousands of photographs of a single star; then measured differences in position of 1/25,000 of an inch. In 1956 we found what we were looking for. We spent another seven years verifying the data before we were certain enough of our evidence to publish the results: an object, which could only be called a planet, was orbiting another star. We had found a planet of Jovian dimensions, the first such planet ever found outside our own solar system.

To make the photographs we used a relatively modest 24-inch telescope. We worked in eastern Pennsylvania, a part of the country not renowned for clear skies. The real search came when we bent over the measuring machine, plotted the results, and then made the mathematical analyses that revealed what no earthbound telescope had ever shown, a planet orbiting another star.

The story actually began in June, 1916, when the astronomical community was surprised by the discovery that a faint red dwarf star was moving across the sky far more rapidly than any other known star. The motion was real. of the sort that astronomers call "proper motion." It takes about 170 years for the star to cross an apparent distance in the sky equal to the moon's diameter; this may sound a bit tortoiselike, but it is far faster than the motion of any star discovered before or since.

The discoverer, Edwin Emerson Barnard, was an amateur astronomer then on the staff of the Yerkes

Search for Other Solar Systems

Observatory in Chicago. It had been known for nearly 200 years that the stars were not fixed on the celestial sphere but move relative to each other. Edmund Halley, whose namesake comet will return in 1986, first recorded these motions. How much a star will appear to move relative to other stars depends greatly on how close it is and in which direction it is moving relative to our line of sight. A star moving straight toward or away from us will not appear to be moving at all relative to the stars around it.

Barnard's Star, a 9.5-magnitude object in the constellation Ophiuchus, has a proper motion of 10.31 seconds of arc annually. It is 5.9 light-years away, the second nearest star. It appears to be moving across our line of sight at about 55 miles a second and to be coming toward us at 67 miles a second. The star's intrinsic luminosity is about 1/2300 that of the sun.

Because of its proximity, Barnard's Star is more than an oddity; it offers the best chance of detecting planets orbiting another star by observing their gravitational effects on the motion of their parent body.

It is not now possible to detect such planets by direct means, for reasons that become clear if we reverse the situation. From the nearest star, Alpha Centauri, the largest planet in our system, Jupiter, would at best appear as a 23-magnitude object separated from the sun, now a first magnitude star, by no more than four seconds of arc. A still fainter earth would be totally lost in the glare of the sun.

Gravitational effects are observable at such distances, however; as long ago as 1844 F. W. Bessel discovered the unseen stellar companions of Sirius and Procyon by this method. The technique works because even if an object has no light of its own, its mass affects the path of a nearby object. Newton's laws of motion tell us that a single star, or the center of mass of a multiple system, will move at uniform speed in a straight line unless affected by some outside force. Any deviation reveals the presence of an unseen companion.

Barnard's Star thus offers a unique opportunity to detect unseen companions small enough to be planets. The task is simply stated: Plot the deviations in the path of Barnard's Star across the sky, and then calculate how large—or small—a body would be required to account for them. Performing the task was something else. The deviations, called perturbations, amounted to about 0.03 seconds of arc. Measuring them was like detecting a one-inch movement at a distance of one hundred miles.

The basic instrument is a long-focus telescope adapted for photography, really just a long-focus camera. The long-focus characteristic yields large-scale portrayal of small portions of the sky, which in turn permits precise measurement of small, angular displacements. The precision of the instrument, the photographic plate, and the measuring machine are such that very high positional accuracy can be obtained. A single photographic exposure furnishes a position relative to a reference background of "fixed" background stars with an accuracy of about 0.04 seconds of arc. Multiple exposures, up to four a night, can improve the accuracy to 0.02 seconds of arc. By further combining several nights' observations into one "normal point," positions with an accuracy of 0.01 seconds of arc or better are obtained.

Measurements must not only be accurate; they must be compatible. As observations are made over a period of decades, the telescope must be kept optically constant, filters and photographic emulsions should not be changed, and not only should the same measuring engine be used but ideally the same person should use it. Use of more impersonal measuring machines in the future may yield further improvements in accuracy over the measurements made so far, which rely on the visual bisection of star images by individual measurers.

At the Sproul Observatory we began a systematic program of measurement in 1937. By the end of 1968 we had 3,036 plates, containing 10,452 exposures taken on 766 nights; these included 25 plates taken during the interval 1916-19 following the star's discovery. The hardest part of the work is not making the photographs, but determining thousands of accurate positions.

The position of Barnard's Star is measured against a reference background of faint stars (*page 38*). Positions are measured in two coordinates, parallel and perpendicular to the celestial equator, known as right ascension and declination. The reference stars are moving too, of course, but because they are much farther away their proper motions are much smaller and are known with sufficient accuracy to be taken into account.

Once the positions are plotted, they have to be corrected for the effects of the earth's revolution around the sun, for the motion of

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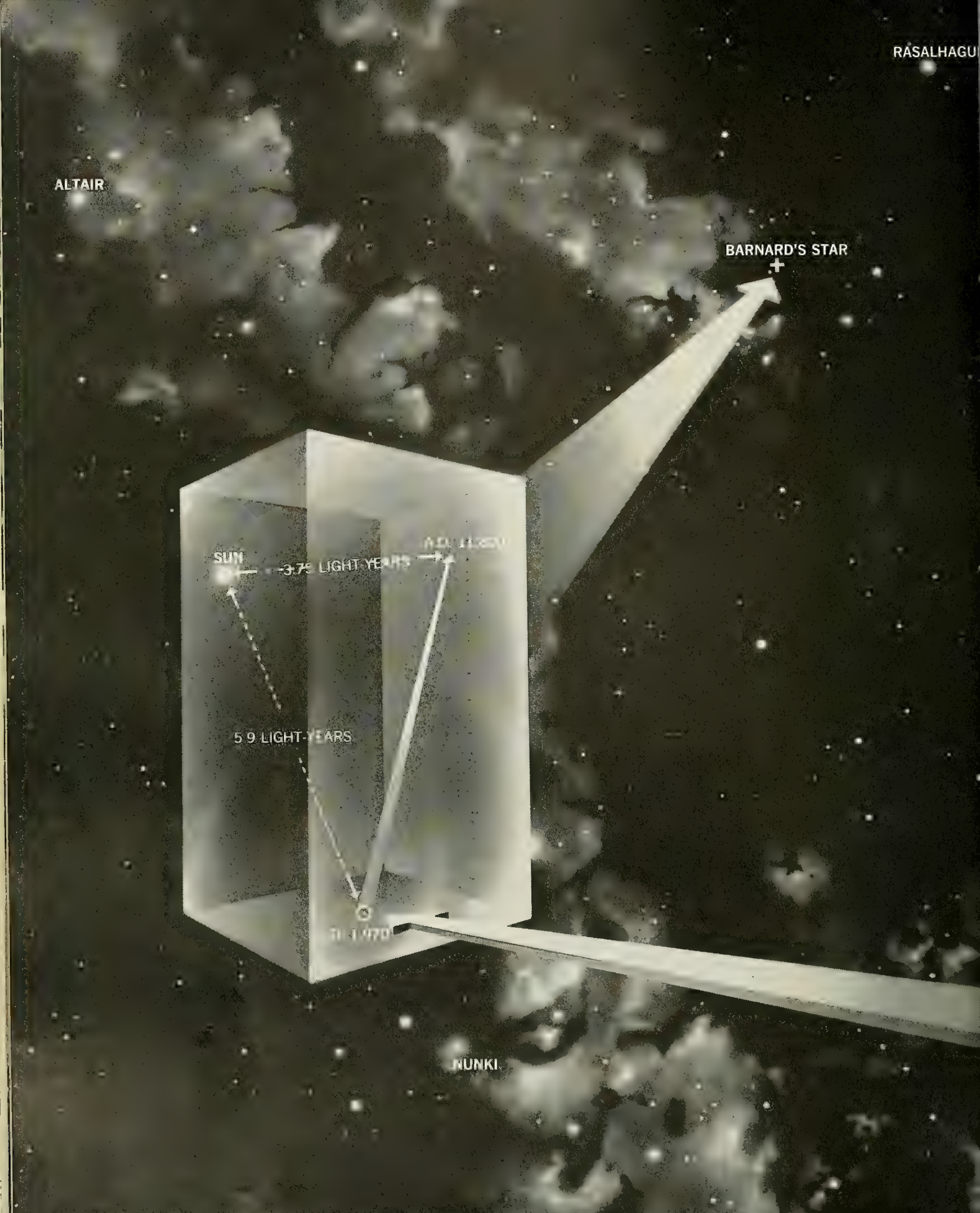
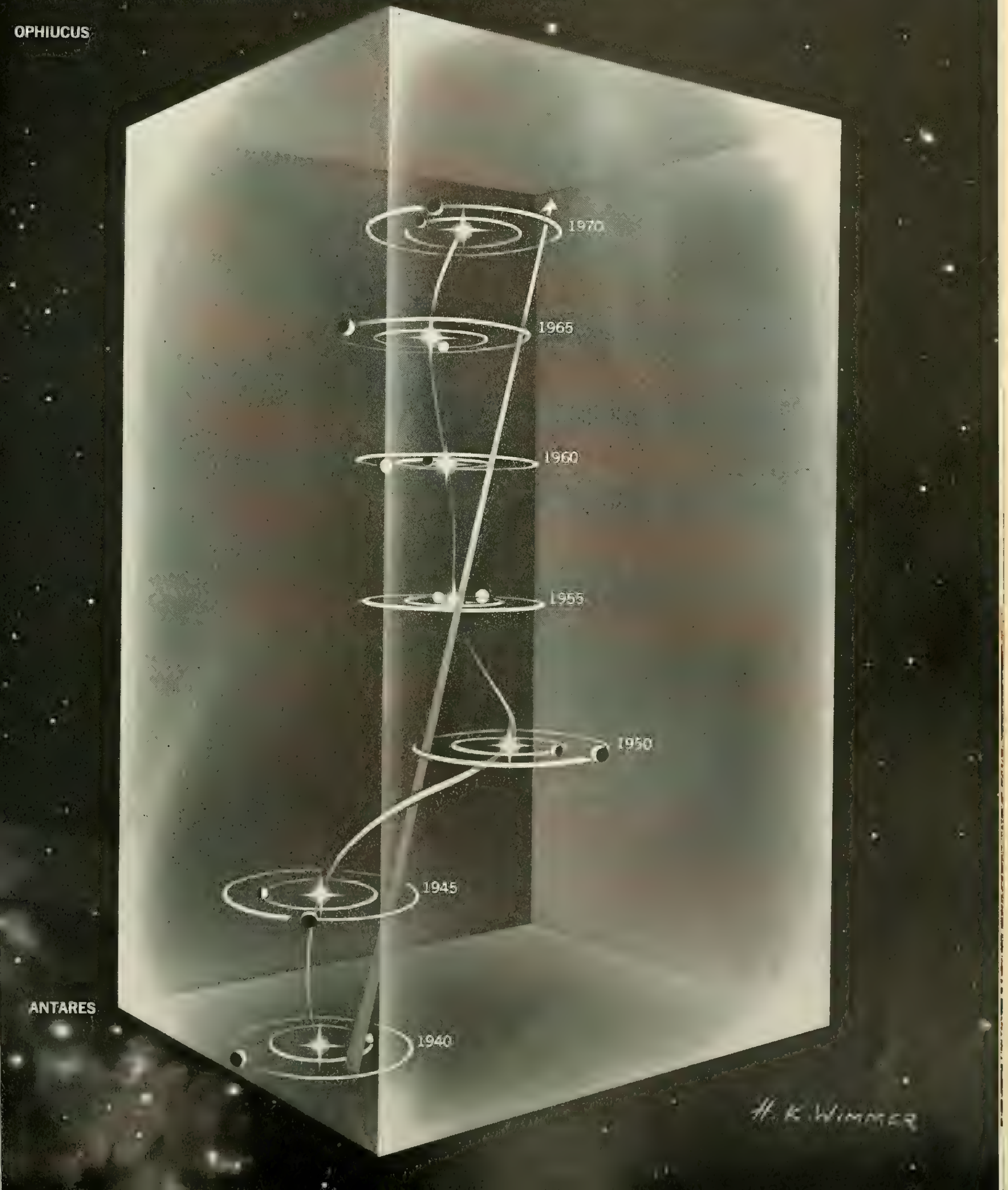
Looking like automobile headlights, these double dots are actually twin images of faint stars caught in two photographs taken 11 months apart. The images that appear tilted in the center are of Barnard's Star. To make this picture the negatives were shifted so that the later image of all the stars fell to the right of the earlier. The images of Barnard's Star appear tilted, however, because of its perceptible movement toward the north (top of the picture) in the 11-month interval.


RASALHAGU
ALTAIR
BARNARD'S STAR
SUN
3.75 LIGHT-YEARS
A.D. 11,800
5.9 LIGHT-YEARS
A.D. 1970
NUNKI

The small cross indicates the position of Barnard's Star in the summer sky, just to the right of the Milky Way. The cube is an enlargement of this part of the universe with Barnard's Star in its 1970 position at the bottom. From our vantage point near the sun, Barnard's Star will close from its present distance of 5.9 light-years to 3.75 light-years by the year A.D. 11,800.

This cube is an enlargement of the path of Barnard's Star in the first cube. It shows the spiral motion (which we see as a wobble) of the star around its mean path (arrow). The size of the wobble has been exaggerated 2,000 times. The viewpoint is from the center of gravity of our solar system, a point never more than about a million miles from the center of the sun. Other effects, like that of earth's motion, have been eliminated. The two planets shown here, moving in the same direction in nearly the same plane in circular orbits, would account nicely for the wobble; the effect of their pulling Barnard's Star out of its path is very clear around 1950, when both planets were lined up on the same side.



the reference stars, for the motion of Barnard's Star itself, and for the changing perspective as Barnard's Star comes closer to us. After eighteen years of photographing, plotting, and analyzing, we found the evidence of perturbations for which we were hoping. When our corrections had all been made, we were left with a systematic deviation, mostly in right ascension, with a cycle approximately one-fourth of a century. The subsequent decade has confirmed this interpretation. There appears to be no other way to explain this deviation than by interpreting it as a perturbation caused by an unseen companion.

If there is just one companion, our calculations show it has a mass one and a half times that of Jupiter and revolves around its sun every 25 years, at a distance 4.5 times that at which the earth circles our sun. Instead of a nearly circular orbit, such as all planets in our solar system exhibit, however, this companion would travel in a highly elongated ellipse. My first reaction to this unexpected feature was, why not? Should we demand nearly circular orbits just because we were born on a planet that happens to have one? My next thought was that perhaps we should be impressed by the near-circular orbits of the planets in our solar system. Immediately an alternate interpretation of the perturbations became possible. Within the uncertainties of the data, the asymmetry ascribed to a highly elliptical orbit could easily be explained by the presence of two planetary companions with different periods of revolution in near-circular orbits. The idea of two companions had been contemplated ever since dips in right ascension turned up in the data for both 1955 and 1956. One dip could have been bad luck: two in consecutive years could not be disregarded so easily. I felt a little as though I were retrograding from the Keplerian viewpoint of elliptical orbits to the Copernican scheme of circular orbits; I felt better after reminding myself that highly elliptical orbits are contrary to the only experience we have.

Simple trial and error (I wasn't going to let a computer do this; I wanted to savor for myself the pleasures of playing with various orbits, for a slide rule and simple desk calculator are all that is necessary in these ultimate studies) showed that two circular, corevolving, nearly coplanar orbits with periods of 26 and 12 years and radii of 4.7 and 2.8 times the earth–sun distance, respectively, represented the observations very well. (The corresponding figures for Saturn are 29.5 years and 9.5 times the earth–sun distance; those for Jupiter are 12 years and 5.2 times the earth–sun distance.) The masses of both perturbing objects worked out to be still closer to that of Jupiter than had the mass of the hypothesized single companion.

Because of the feeble luminosity of Barnard's Star, the two planets would have surface temperatures so low that any discussion of life on them is out of order.

It seems clear that these two companions, which I call simply B1 and B2, are true planets and not just very small stars in a complex multiple system. Both stars and planets are spheres of matter. Stars result from spheres of matter having so much mass that contracting under the force of gravity, they heat up enough to start nuclear reactions and glow with their own light. Their mass classifies them as stars even if at the end of their life they collapse to planetlike dimensions. Planets are considered to be the end product of smaller contracting spheres that lack sufficient mass for nuclear reactions, or possibly the result of the accretion of scattered material. Planets never shine by their own light.

The present study does not permit any interpretation that would involve more than two planets. It would be totally impossible to discover a planet the size of the earth. The mass of the earth is only 1/319 that of Jupiter, not enough to cause noticeable perturbation of the central star.

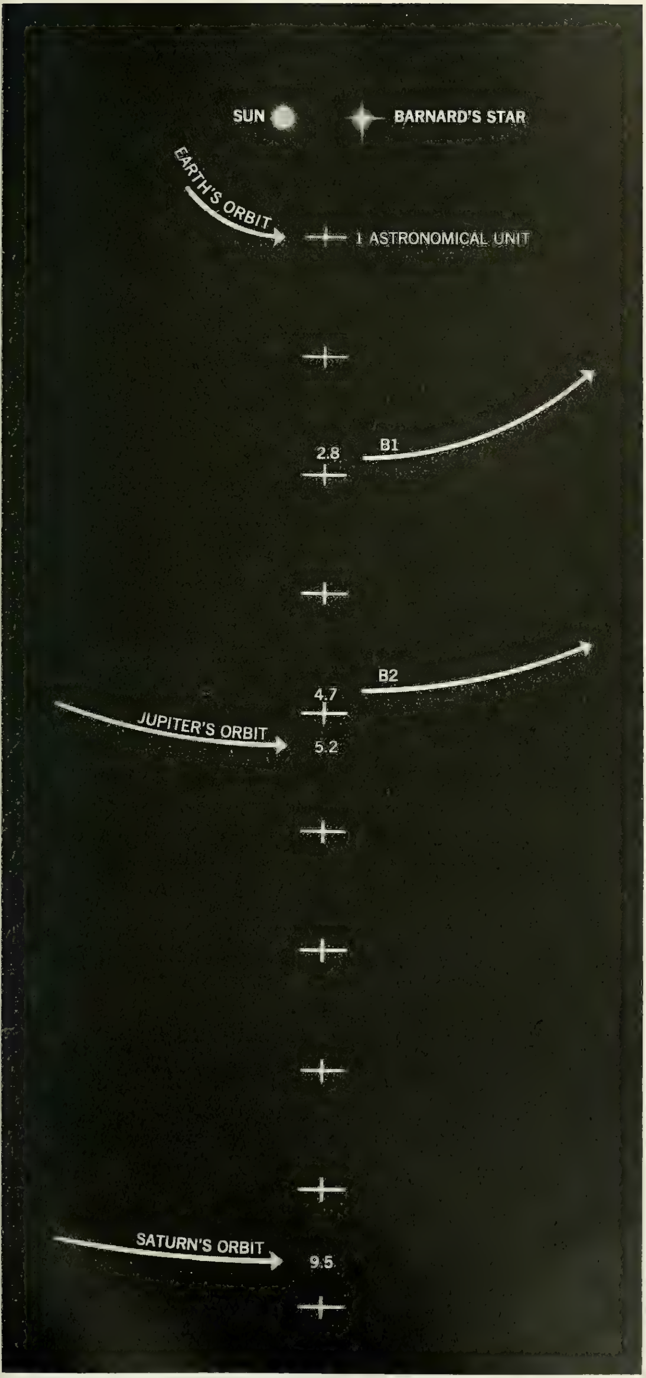
This gravitational technique is so sensitive, however, that if Barnard's Star had no unseen companions, it would show deviations caused by the perturbations of Jupiter and Saturn on our sun. The wobble of the sun in its path caused by Jupiter and Saturn, and to a lesser extent by Uranus and Neptune, is large enough to produce wobbles in the paths of nearby stars. The wobble produced in Barnard's Star is not enough for Jupiter and Saturn to be discovered if for some reason they had been previously overlooked, but it is large enough to be allowed for in analyses of the path of Barnard's Star.

The size of the perturbation observed in Barnard's Star makes it certain that something is there; the amplitude is ten times the margin of error. Whether the one- or two-planet hypothesis is to be preferred may be decided in the next several years, when we can test our predictions against new observations.

To date, Barnard's Star is the only star other than our sun to show clear evidence of having planets. Other nearby stars are under intense study, and there appears to be some tentative evidence for planets circling still other stars, but any definite statement is several years away. Barnard's Star is the second closest to us. The farther away a star is, of course, the more difficult it is to detect the very slight wobble any planets would cause.

The search for extrasolar planets has been going on for 32 years, slowly, painstakingly, with none of the excitement of more glamorous fields of science. Curiosity, patience, perseverance, and faith remain basic and continued requirements. Natural limitations are ever present. The scientist is destined to create the universe in his own image and in that of his times. In the

Scale drawing compares orbit
in our solar system wit
those of planets orbitin
Barnard's Star. One astronomica
unit is the mean distanc
from the earth to the sun
about 93 million miles



present case he is bound to be influenced by what he knows about the motions and physical properties of the planets in his own solar system. The temporal extent of his observations prejudices him and permits him to discover only events with cycles not exceeding the interval covered by the observations. And because of unavoidable limitations in observational accuracy, the size of deviations sets a lower limit to what he can discover in the way of perturbations.

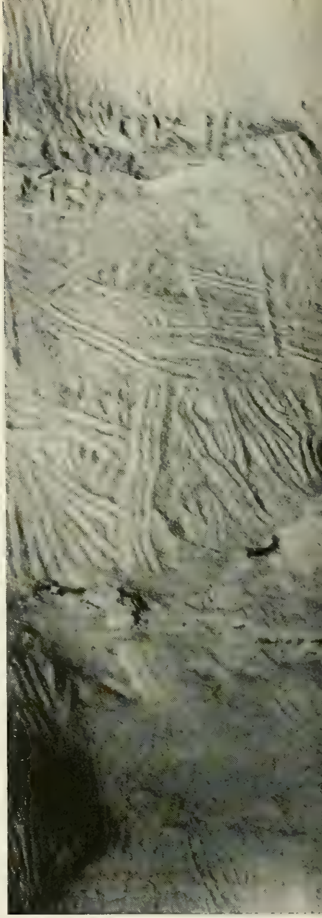
None of this is reason for despair. It is a good principle in science not to overdiscuss; there is no merit, however, in underdiscussing the available data. Deviations from existing knowledge lead to new insights. Unexpected and unforeseen discrepancies are one of nature's ways of beckoning us, drawing attention to facts that are asking to be discovered. Frequently, such revelations are ignored or swept under the rug. Such reaction is hardly in the spirit of scientific adventure. We need insight and the courage to heed nature's signals.

It is sound procedure to carefully examine and check our techniques, thereby insuring that deviations from prior knowledge do not result from human and instrumental errors. Such procedure is even more desirable if the discrepancies indicate the existence of the very phenomenon we would be happy to discover. Only after having eliminated possible errors should we, still a bit reluctantly but with a sense of relief and exhilaration, accept the observed pattern as having cosmic reality. In our case we appear to be operating well above the threshold of what can be observed, and there is little reason to doubt the reality of the data. We should not be afraid to draw the apparently inevitable conclusions. Lest we perish, we should dare to have vision; while we need not be fools rushing in, there is no reason why we cannot tread carefully and still be on the side of the angels. We should be hopeful, have faith, and be ready and willing to take a chance on meeting the revelations of the universe more than halfway. ■

PREHISTORY DOWN UNDER

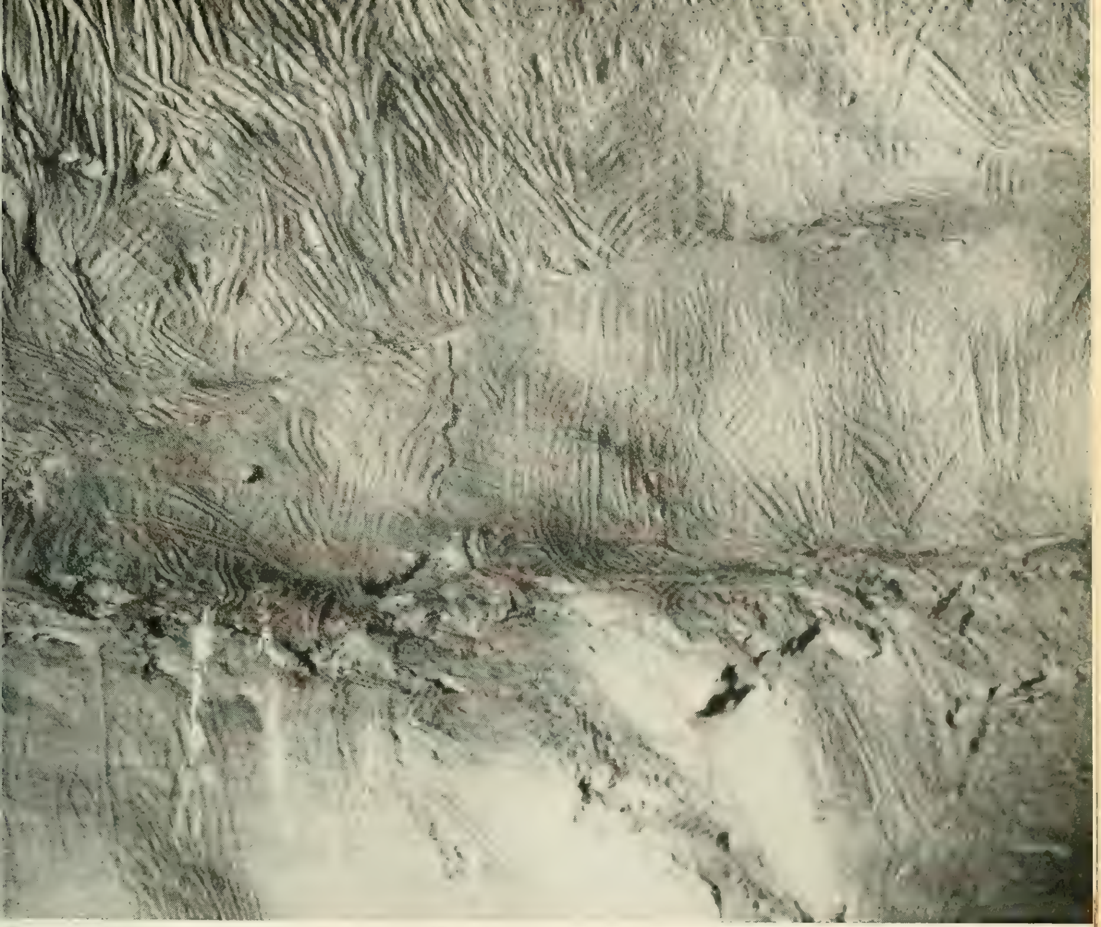
Archeology illuminates the dark continent of prehistory, as Aboriginal settlement and artistry are traced further back into Australia's antiquity

by D. J. Mulvaney



With a perspective of history that reflects their European origins, Australians are now celebrating the bicentennial of Capt. James Cook's "discovery" of Australia in April, 1770. When Cook took possession of the eastern half of the continent for his British sovereign, however, upward of 250,000 people had been in occupation of Australia for considerably more than 25,000 years. Prehistorians have a rewarding task in assigning a vital role to the Aborigines in the story of Australian settlement. and the evidence they are uncovering is impressive.

Australia, the only continent whose prehistory ended with the Industrial Revolution, possesses advantages that make it a unique laboratory for the study of ecological and cultural relationships that existed during the stone-using hunter-gatherer stage of human social organization. Superficially, at least, this society appears akin to long extinct Paleolithic communities in other continents. This explains its fascination for evolutionary social



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left, recently excavated
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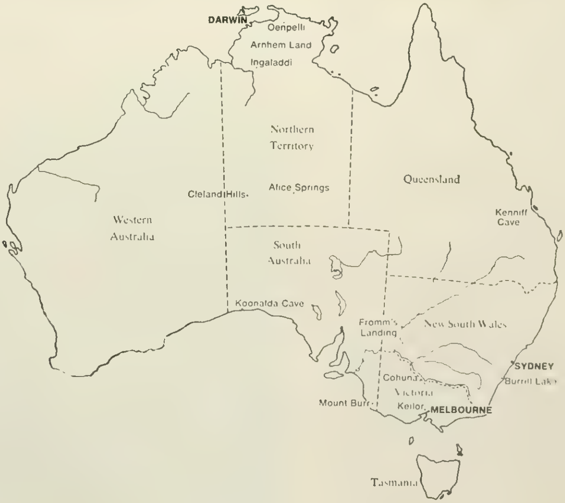

DARWIN
Oenpelli
Arnhem Land
Ingaladdi
Northern Territory
Queensland
Alice Springs
Cleland Hills
Western Australia
Kenniff Cave
South Australia
Koonalda Cave
Fromm's Landing
New South Wales
SYDNEY
Burrill Lake
Cohuna
Victoria
Mount Burr
Keilor
MELBOURNE
Tasmania

theorists of the nineteenth century, including Lewis Henry Morgan, whose *Ancient Society* borrowed from Australia, and Edward B. Tylor, who contributed a paper on "The Tasmanians as Representatives of Palaeolithic Man."

Unfortunately, these early workers treated Aboriginal institutions and implements like butterflies impaled on a collector's board. They assumed that the Aborigines were living fossils whose customs, possessions, bodily form, and even mental capacity had survived unaltered since the dawn of mankind. Accordingly, they classified them rigidly. They assumed further that this arrested development persisted in a harsh land of unchanging environmental conditions. This attitude bred an intellectual scorn for the "poor, primitive savage," while the static and selective concept of both culture and environment was artificial and misleading.

Aboriginal society is undergoing close scrutiny today, but the conditioning philosophical notions of the investigators have changed. Aboriginal life and the natural environment are recognized as being dynamic, interrelated, and fluctuating. While the Aboriginal situation is still studied because it offers insight into, or is analogous to, life at a comparable economic subsistence level in Paleolithic times, this is an incidental consequence. The chief interest is in the Aborigines as people and in their past adaptations to the natural environment.

Fundamental research in Australia can contribute substantially to the sum of world prehistory. This is the only continent where nonagricultural/pastoral people have retained total occupancy into the "ethnographic present." Although rarely attempted, it has been possible (and in some regions, it still is) to record and analyze the role of an individual Aboriginal hunter; the technological and economic organization, as well as the artistic and ceremonial life, of entire communities; and the spiritual bonds and linguistic affiliations of those societies.

Archeologists can examine sites that were not disturbed by later agriculture or industry, where organic materials are frequently preserved. There are even unique examples of perishable Stone Age field monuments surviving. Impressive "canoe trees," for example, their trunks scarred where the bark has been removed to make watercraft, still line some waterways.

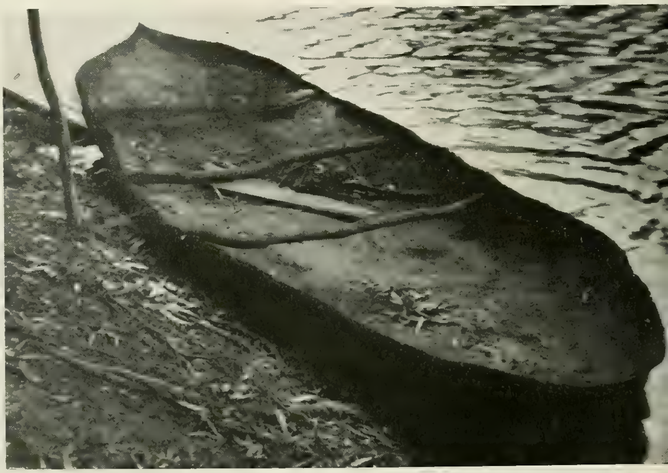
The unrivaled opportunity still exists to meet Stone Age men—to talk with the present occupants of an archeological site about its function, or to be led to a ceremonial or art site by its owners, who can explain its meaning. In these circumstances, it is possible to document aspects of ethnoarcheology—for example, the manufacture and use of tools by Aboriginal craftsmen and the resultant effects of wear—that are of concern to all prehistorians of the Stone Age.

The ethnographic specimens collected in museums, the relatively bulky written records and sketches by early explorers, settlers, and anthropologists, and the oral sources mentioned above facilitate ethnohistorical reconstruction. In this way, the pattern of Aboriginal life near the end of its prehistoric phase can be presented as a form of history. This evidence also contains valuable clues concerning the demographic situation at the time. Population estimates of these hunter-gatherer groups, although rather vague, are probably more reliable than figures for any comparable society in the past and are therefore relevant to any discussion of prehistoric world population densities.

Collated with the results of ecological research, such data also provide insight into the flora, fauna, and landscape immediately preceding the drastic impact of farmers and pastoralists. Of even greater significance is the possibility of eventually reconstructing the environment at the time of initial Aboriginal colonization. Then the role of the nomadic Aboriginal, his dog, and his firestick as factors in transforming plant and animal communities will be clarified. There are hints that these factors were far-reaching in their effect, and some authorities believe that, particularly through fires instigated by man, huge tracts of forestland were converted to open grasslands, and that the giant marsupial fauna became extinct only after man's arrival. But such theories require unequivocal proof, and field work to that end is in progress.

Australian prehistorians are at present preoccupied with a chron-

"Canoe tree," right, shows scar in its trunk left by the removal of bark for an Aboriginal canoe, similar to the one that appears below.



ological leapfrog. Ten years ago, the oldest carbon 14-dated Aboriginal site positively associated with man was about 8,500 years B.P. In 1962, my excavation at Kenniff Cave, Queensland, took prehistory firmly into late Pleistocene (Ice Age) times, with dates back to about 16.000 years. Then the work of other archeologists produced ages of 20.000 years and more for occupation in Arnhem Land, in the north, and at Koonalda Cave, on the Nullarbor Plain near the southern coastline. More recently, a cave at Burrill Lake, on the eastern seaboard south of Sydney, also proved to have been occupied 20,000 years ago.

Greater antiquity is probable, but until substantiated by further field work, it remains less securely based. There is presumed human association with an age of perhaps 26,000 years at Lake Menindee, in western New South Wales; a comparable antiquity is inferred at another site in that region, and field work is in progress. Just outside Melbourne, the Keilor soil pit produced a date of some 31,000 years, which the excavator, A. Gallus, associates with human occupation. He infers even greater antiquity for other finds, but his interpretation of the fractured stone at this site is disputed by some archeologists, who consider natural factors a possible explanation.

Within a few years, then, Australia's human time-span has been trebled, and the initial colonization is firmly based in the last major stage of the Pleistocene ice advance, if not earlier. This implies that at the time of this migration, sea levels were lower by 300 feet or more, and vast plains emerged from the seabed to the north of Australia, adding perhaps 10 percent to the area of the continent. New Guinea and Australia were connected, and the flat plains extended toward Indonesia, cutting the extent of water separating insular southeast Asia from Australia, but never bridging the ocean deep of Wallacea, the region of the Wallace Line of zoogeographic fame. Migrants therefore required some form of watercraft.

The most significant archeological discoveries within recent years concern human fossil remains. N. W. G. Macintosh, of Sydney University, has reappraised existing data, concluding that two basic groups are represented in the fossil record. One group (which includes the presumed terminal Pleistocene-aged Keilor cranium) possesses many characteristic modern features, implying that people with the morphology of modern Aborigines had reached southern Australia by the late Pleistocene.

The second group has many archaic features, and as their presumed age is comparable to that of the first group, it raises the possibility that they coexisted within the same region of Australia. This provides the background to recent significant discoveries by A. G. Thorne, also of Sydney University, who has located a number of fossils of the archaic group buried in a sand lunette not far from the Cohuna site, where an archaic cranium was found many years ago. So far, he has discovered seven individuals, and further finds are anticipated from large-scale, interdisciplinary excavation.

The deposit in which the burials occur is undated at present, but it is presumed to be at least 20,000 years old. The bones are heavily mineralized and carbonate encrusted. All individuals possessed very rugged features; the jaws and brow ridges were massive, the cranial bone was exceptionally thick, and the foreheads receded more than in any other known Australian specimens. Indeed, some of these characteristics suggest comparison with the Javanese fossils of *Pithecanthropus (Homo erectus)*, whose order of antiquity is some half-million years.

Thorne's definitive report on these remains will constitute a landmark in Australian physical anthropology. Normally, a researcher has to interpret single and fragmentary fossil finds. In this case, with seven individuals already obtained from the one site, including postcranial bones, he has available for analysis a unique and challenging human population.

Australian prehistory contains other surprises. During 1964-65, in the course of research at The Australian National University, Carmel White excavated several sites in the Oenpelli area, Arnhem Land. In two of them, radiocarbon dates back 18,000 to 23,000 years were obtained, and in both instances this occupation was associated with the use of edge-ground axes. Such an antiquity for grinding techniques was unexpected, and interest was further enhanced because some of the axes were shaped in a tapering or waisted fashion, while others possessed deliberate grooves. These technological developments were once considered the type indicator of the New Stone Age.

Interest then focused on the antiquity of Aboriginal art. The deposit at Kenniff Cave contained ocher fragments throughout, and some indefinite esthetic purpose might be inferred from their presence even in Pleistocene levels. The real breakthrough in this regard was made at Koonalda Cave, a site used by prehistoric artisans as a flint quarry. In total darkness deep inside the cave, hundreds of square feet of linear finger tracings and grooves cover the soft limestone walls, in a style and arrangement reminiscent of some Paleolithic caves in France. A massive rock fall that crashed down against them coincidentally allowed a minimum age to be assigned to these designs. Subsequent flint miners, working in the dark, had tossed burned wooden torches onto this rubble, thereby piling up ideal radiocarbon samples against the future. This wood is older than 18,000 years, giving the wall art an age greater than many classic European Paleolithic art sites, and proving that the early Aborigines possessed an esthetic sense.

The motifs engraved on Koonalda's walls include simple finger tracings and linear incisions, but their purpose and interpretation are debatable. Across the continent, however, in a shelter at Ingaladdi, 200 miles south of Darwin, excavations recovered several sandstone fragments with similar abraded grooves. Presumably, they had disintegrated from the rock face, and when they fell, they scattered over the prehistoric habitation floor. Because an accumulating deposit later buried them below three feet of occupational debris, their minimum age is the age of the layer in which they were imbedded, and this dates from 5,000 to 7,000 years ago.

Whatever the purpose of these markings, further evidence for a remarkable stylistic continuity through time comes from the same district. Observations made during this century by anthropologists at a nearby Aboriginal ceremonial site at Delamere cattle ranch establish that similar abraded grooves were rubbed into the rock by Aboriginal participants during rain-making rituals. Calcite crystals were also used in these ceremonies, and it is therefore relevant that we excavated similar calcite crystals in the Ingaladdi deposit.

From studies of contemporary Aboriginal rituals the prehistorian also learns that more of the decorative devices are designed for destruction than for permanence on rock surfaces. Indeed, the time and trouble taken to produce perishable art forms—body painting, intricate ceremonial regalia destroyed during the ceremony, and large-scale ground paintings and sand drawings—far surpass that spent on the rock art by which Paleolithic societies are known.

A major survey and film record of Central Australian rock art, undertaken by Robert Edwards of the South Australian Museum, has disclosed many engraved sites. From the extent of their patination and weathering, he inferred they were of great antiquity. The most remarkable of such galleries is in the remote sandstone Cleland Hills, west of Alice Springs. In addition to the familiar linear motifs of other sites, there are striking engraved human figures of some artistic merit, staring from the past with owlish gaze.

The Australian Institute of Aboriginal Studies recently sponsored a major salvage project at Mount Cameron West, in northwestern Tasmania. Work centered on a large gallery of art engraved upon soft eolianite, wind-deposited rock, situated on an exposed ocean beach. Excavations showed that drifting sand had covered many engraved rocks, and that previous human occupation of the site had resulted in an accumulation of midden against the lowest rocks. Radiocarbon dating of charcoal from this level, therefore, should provide a minimum age for the art. A consideration of interest to Edwards, who photographed the site, is that circles and other art forms on this monument are reminiscent of designs on those Central Australian sites to which he attributes great antiquity.

Tasmania is archeologically intriguing. The rising seas following the melting of the ice sheets made it an island some 10,000 years ago. As far as can be ascertained at present, its Aboriginal population arrived by land before that time and thereafter remained isolated from outside influences until the fatal impact of the European arrival in the late eighteenth century.

Ancestors of this present-day Aborigine came from Southeast Asia to occupy Australia more than 25,000 years ago. At right, following a successful kangaroo hunt the animal is cooked in a hollowed-out mound of ashes.

Their way of life at that time was materially simpler than that of the mainland Aborigines, and excavations have shown that apparently their stone technology did not change significantly during the long duration of their occupation of Tasmania.

It seems justifiable to assume, therefore, that Tasmanian material culture, particularly its stone equipment, reflected the technological status attained by mainland Aboriginal society about the end of the Pleistocene. It is tempting also to infer that Tasmanian rock art was part of the "invisible baggage" of these early migrants. If the art style does prove to be so ancient, however, the possibility of continuity of tradition emerges. About A.D. 1800, the Tasmanians were seen to draw similar motifs on sheets of bark.

It has become a truism of Australian archeology that the older layers on many excavated mainland sites contain types of stone tools whose affinity with the Tasmanian material seems close. Both these early mainland collections and Tasmanian implements are made of cores or flakes. Blade tools are absent from Tasmanian collections. The distribution of a considerable variety of small and carefully trimmed blades and points is limited to continental Australia, where their first appearance, 6,000 to 7,000 years ago, came long after Tasmania became isolated.

This technological change from core and flake production to blade tools was vividly illustrated at Ingaladdi. The lower layers, which

Rock paintings, left, at Delamere cattle ranch, adorn Aboriginal site used during rainmaking rituals.

Less than 50 miles away, painted figures such as the one at right, some almost ten feet tall, gaze from stone walls at Ingaladdi shelter.

Below, painted animals cavort on a rocky overhang at the bottom of a canyon wall.

contained the engraved rocks, also produced numerous trimmed flakes (scrapers) and small cores that apparently had served as chopping or planing tools. The upper layers contained a different assemblage, consisting primarily of thousands of small, pointed blades, presumably projectile points, carefully retouched on one or both faces. This dichotomy between an earlier flake and core industry made on fairly large pieces, and a later, small blade and flake complex, has been reproduced at several excavated deposits across the continent, including those at Kenniff Cave and Burrill Lake. The form these tools take is subject to regional variation.

Another rock shelter that seems to follow this pattern is on the slopes of Mount Burr, an extinct volcano in southeastern South Australia. Men occupied it over 8,000 years ago, although the area was still volcanically active. Nearby, Mount Gambier last erupted little more than 4,000 years ago. This is a reminder that the Aborigines have adapted to many far-reaching environmental changes since their arrival in Australia: the seas rose and the coastline shrank, inland lakes dried up, major river systems flowed intermittently, and numerous volcanoes on the extensive southeastern basalt plains became extinct.

Certain changes may have been assisted by the Aborigines. Early explorers commented upon their widespread practice of firing the countryside, and this regular burning, particularly of semiarid landscapes, may have produced drastic changes in vegetation cover, native fauna, and soil erosion.

Predatory man also introduced another scourge of native fauna, the dingo—a reddish-brown wild dog. It must have crossed the seas from Asia with man at an early date in the history of animal domestication. The earliest evidence for its presence in Australia consisted of a 3,000-year-old skeleton excavated at Fromm's Landing, South Australia. Subsequently, bones that may be 8,000 years old have been recovered at the Mount Burr shelter, so that dogs had reached the southern coast by that early date.

On present evidence, therefore, it appears that man, the hunter and food gatherer, probably arrived on this continent before the settlement of the New World. Even 20,000 years ago, he possessed artistic and technological skills that earlier prehistorians would not have attributed to him because they assumed that the Aborigines were so "primitive." In both adapting to and shaping the Australian environment, the Aborigines left traces that research can transform into prehistory.

THE MANY CLOCKS OF MAN

The 24-hour period is only one of the biological rhythms of human life

by John D. Palmer

In most cases the intervals of time we recognize are arbitrary, man-made designations. Periods such as seconds, hours, or weeks, plus the more esoteric intervals—weekends, the "cocktail hour," vacation time—are obvious cerebral artifacts of our present civilization. Mixed in with all the arbitrary units of time is the period of a day. A day is the interval between successive sunrises and is generated by the rotation of the earth on its axis in relation to the sun. At present, days are 24 hours long, but just a short 370 million years ago (a fleeting instant in the 4.6 billion years that the earth has existed) the earth gyrated more rapidly, and days were only 22 hours long.

At first thought one might decide that the 24-hour day is just another arbitrary interval of time chosen by man because of its ease of recognition and its convenient duration. We sleep at night; work and eat in the daytime. If no other clues were available to know what to do next, we would need only to look for the sun. Still, we know that men isolated from all view of the sun and from man-made timepieces—either deep in a cave or in soundproof laboratory quarters—still continue to settle down for the "night," to eat, and to regulate their activities around a 24-hour schedule. And while this evidence is often said to reflect our adjustment to a heavenly time interval, it may also be interpreted to mean that this 24-hour rhythm is an intrinsic characteristic of man's inner workings.

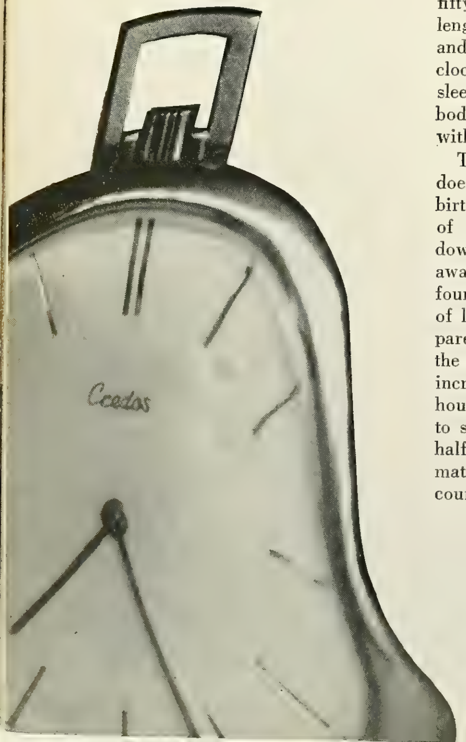
This period is also found to be a constant feature of plants and animals (NATURAL HISTORY, March, 1966; February, 1967). As shown by literally thousands of observations, organisms maintained under laboratory conditions in which all time clues are eliminated still continue to measure out 24-hour periods with surprising accuracy, leading some researchers to conclude that a period of approximately 24 hours is a fundamental attribute of protoplasm. It may be that a period of 24 hours is a kind of absolute in the biotic kingdom. Scientists are now aware that within the bodies of all organisms is a "living clock" signaling off these periods.

One concrete example of these rhythms is the sleep–wakefulness cycle in man. About ten years ago, a young speleologist became obsessed with the idea that it was scientifically important for him to live in an ice-filled cave, sans clocks, for a protracted period of time. For sixty-three days he lived 375 feet below ground where the temperature held constant at 32° F., the relative humidity remained unchanged at 100 percent, and the darkness was complete save for a small, battery-powered light. Each time he awoke, ate, or prepared to retire, he called over a field telephone to a surface camp, where the times of the calls were recorded. The inexorable cold and dampness reduced his body temperature to less than 97° F., and he was constantly threatened by avalanches and cave-ins—still he held out for the sake of science and whiled away his time writing a best seller on his subterranean adventures. Throughout his underground stay he tried mentally to keep track of the passage of time on the surface. When the men in the surface camp informed him on September 14 that his experiment was over, he estimated the date at August 20. His judgment of the passage of time had been exceedingly sluggish. Mentally, he had lost 25 days! However, his living clock (as evaluated by the times of his retiring/awakening phone calls) had ignored his mental confusion and guided his body functions all the while, measuring off periods of activity and sleep that totaled just longer than a day: 24 hours and 31 minutes on the average.

A slight deviation from an exact period of 24 hours is the rule rather than the exception when plants and animals are maintained in strictly unvarying conditions. However, a slight inaccuracy should not dethrone the 24-hour period as an absolute, for when one contemplates the possible intervals from less than nanoseconds to the life-span of the universe, a "near-miss" to 24 hours should be leniently accepted. After all, even the atomic clock of the Bureau of Standards, the paragon of accuracy, mysteriously slows down every sunrise.

As seen in the graph on page 55, because the period of the cave dweller's rhythm was slightly longer than 24 hours, his sleep–wakefulness cycle fell out of phase with the actual day–night cycle. Only once again during the experiment did it come into phase with the day–night cycle outside, bringing about a rather interesting result. "Daily" during his underground sojourn in this quasi limbo, he entered limited scientific observations and numerous complaints in a log. Save for one entry, the diary is a hodgepodge of chronicled discomforts, misadventures, perpetual intestinal uprisings, cave-ins, and real and imagined terrors. In this particular entry, however, the diary tells us that "for the last few days I have felt very optimistic, I suffer less from the cold; I am better adapted to conditions." During this optimistic period (days 36-39 on the graph) his sleep–wakefulness rhythm was again in phase with normal day–night cycles in the French Alps outside the cave.

Since this pioneering venture, more sophisticated, more comfortable, and considerably less dangerous observations of man in isolation have been carried out, especially at the Max Planck Institute in Germany. In these experiments, light and temperature (the major time-signaling cues of our environment) can be held rigorously constant, while subjects remain in isolation for many weeks.



Despite the relative comfort of the modern experimental setup (including kitchens and baths), it is still difficult to obtain a suitable number of volunteers. Few people are willing to subject themselves to the rigors of prolonged isolation and the indignities of continuous medical measurements. Luckily, money can entice some into cooperating, and in the end investigators turn to that always popular experimental subject—the graduate student. His captive willingness is enhanced by his penury, and in exchange for three meals a day, the quiet of constant conditions in which to study, and a temporary escape from the pressures of graduate school, he is more than willing to provide periodic blood and urine samples and to sit impaled on rectal temperature probes for days on end. This traditional exploitation has an additional advantage—the student, as a burgeoning scientist, can relate his experiences to the investigator in a meaningful way after the experiment is over.

In the last few years more than fifty subjects have lived for various lengths of time in these bunkers, and in all cases their internal clocks continued to govern their sleep–wakefulness pattern and other body rhythms in close accordance with the 24-hour time period.

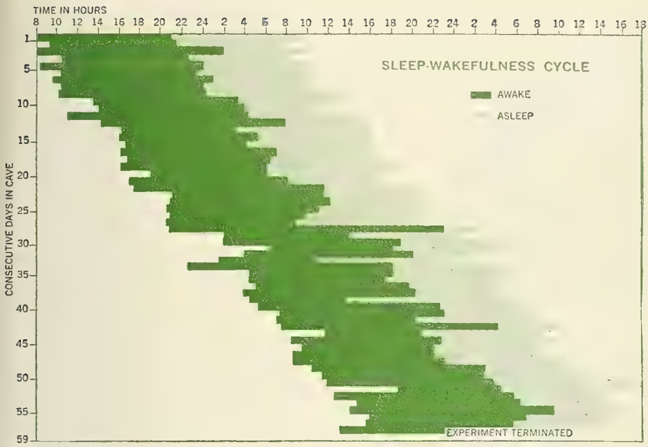
The sleep–wakefulness rhythm does not appear to be present at birth. In a study in which parents of newborns were asked to jot down the times that their babies awakened or fell asleep, it was found that not until the third week of life were signs of a rhythm apparent. During the next few weeks the neonates' nocturnal sleep time increased to an average of ten hours while the day sleep decreased to slightly longer than three and a half hours, beginning to approximate an adult pattern. It is, of course, several years before all day sleep is abandoned. In most of these studies the children were raised in the usual pattern: the parents, for convenience' sake, actively labored to develop sleeping patterns in their newborns that would be similar to their own. However, interesting data came from one set of indulgent parents who allowed their child to determine its own sleeping pattern. In this case, a pattern of sleep geared to a 24-hour day did not develop until the child's eighteenth week of life.

Apparently the major stimulus for the development of a sleep–wakefulness pattern is the parents' concern for getting the child's schedule to conform to their own. However, maturation of the child also plays an important role, as is shown in studies of premature babies. Rhythmicity in these tiny infants develops much more slowly than it does in full-term neonates, despite hospital pressures, to get them to conform to a daily pattern.

The living clock may also function in a related aspect of sleep: the ability of some people to awaken at a predetermined time each morning without the aid of an alarm clock. All men are not equally endowed with this capacity, and those who have it show different degrees of accuracy. Various idiosyncratic rituals have been developed by some people to impress the waking time upon their minds: one expert stamps out the desired hour on the floor—much like the old counting horse of vaudeville—before retiring; and another, a politician, slowly raps out the waking hour with his forehead against the bedpost while patriotically whistling "The Star-Spangled Banner."

Temperature rhythms

The body temperature of man is also something of an absolute. Under the control of an elaborate thermostat located in the brain, body temperature is regulated at about 98.6° F. Like the interval of 24 hours, this too is a "relative" absolute in that body temperature is not perpetually 98.6° F., but varies by a few degrees around this average. In 1842 it was discovered



that in the small hours of the morning one's temperature is low, rising to a maximum during midday or afternoon. An afternoon temperature slightly over 99° does not necessarily mean that one is slightly feverish, while the same temperature in the morning could indicate febricity.

Since body temperature depends on the balance between heat production and loss, one immediately thinks of the effects of muscular activity, food intake, and sleep as the causal factors of the rhythm. While all these factors exert profound influences on body temperature, they are not the causes per se of the rhythm. Studies in which subjects are confined to bed for several days, eating identical meals at regularly spaced intervals or fasting, show that these treatments do not abolish the rhythm or decrease its amplitude. One man, completely paralyzed with poliomyelitis for sixteen months, still displayed a normal temperature rhythm.

Because body temperature is so easily measured, it is one of the most commonly studied human rhythms. Like other body rhythms it has been shown to persist whether in the constant conditions of deep caves or in the laboratory. For example, before the start of their lonely confinement in the experimental bunkers described earlier, rectal temperature probes were implanted in each volunteer so that deep body temperature could be continuously recorded during the times of wakefulness and sleep without disturbing the subject. Even in these static conditions, all subjects displayed distinct temperature rhythms. A particularly interesting case is shown in the graph on page 56. This subject displayed a sleep–wakefulness rhythm with a period of 33 hours, but a temperature rhythm with a period of a more normal 24.8 hours. Therefore, the individual "lost" over 5 days during his stay in constant conditions, while his thermostat lost only half a day. A possible conclusion to such a finding is that the body must have multiple clocks, each controlling a specific function.

Several studies show that man's mental abilities and physical dexterity vary rhythmically over a 24-hour span and that the forms of these rhythms are similar to the form of his personal daily temperature curve. For example, the speed of performing such simple tasks as dealing four hands of cards, sorting a deck of cards by denomination, or multiplying eight digit numbers by each other is studied at various times over the day. These, along with reaction times and steadiness of the hand, are commonly found to be rhythmic. When the subject's temperature curve is simultaneously determined, its form and the forms of the above parameters are usually similar.

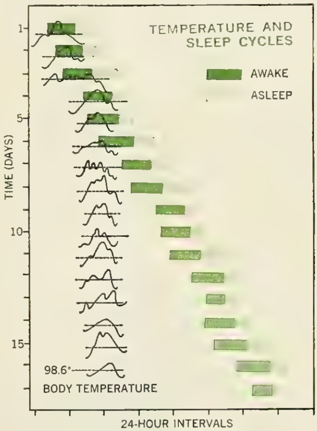
Experiments such as these, together with a plethora of similar findings, suggest a causal relationship between body temperature changes and efficiency. The relationship is further strengthened by the finding that "morning" people —those who rise early and work, learn, or perform best in the morning—have temperature curves that reach their daily maximum before noon; while "evening" people have temperature curves that peak in the late afternoon or early evening. The latter case, in which peak performance is delayed until late in the day, discredits the old adage that "sleep recharges the body like a battery" and that body energy gradually runs down during the day.

Rhythmic time perception

A few years ago it was found that one's subjective time perception varies rhythmically. For example, if a subject is asked to estimate the passage of a 60-second interval at different times of the day, he tends to overestimate—indicate periods longer than 60 seconds—when his temperature is lowest and underestimate when it is at its peak, suggesting that the rate at which an endogenous physiological "time-perception" mechanism runs is dependent on body temperature. This is a logical conclusion, for it is well known that all metabolic processes run faster at higher temperatures. Therefore if this clock, which would be expected to be a metabolic entity, was caused to run faster by higher temperatures, then the subjective evaluation of time would be shorter, and vice versa. This deduction was proved experimentally many years ago by an eminent physiologist who capitalized on his wife's bout with influenza. Throughout her illness she indulged him by estimating 60-second intervals while he recorded her attempts with a stopwatch. The higher her fever, the quicker she supposed time to be passing. These findings have now been confirmed many times by artificially augmenting human body temperature with exposure to diathermy or drugs.

The body's chemical rhythms

Many, if not all, of the myriad chemical reactions that take place within the human body are probably rhythmic. Because the end products and excesses of some of these reactions are excreted from the body in the urine, the progress of these inner body reactions can be followed by urinalysis. Just about every component easily analyzable in the urine—potassium, chlorine, sodium, phosphate, and hormones, plus pH and water volume—are found to vary rhythmically, with peaks occurring in the daytime and minima at night. These rhythms make their first appearance in the newborn between the fourth and fifteenth week of life, and are not caused by diet, activity, sleep–wakefulness, or other cycles.



An interesting and unusual series of observations on excretory rhythms has been carried out north of the Arctic Circle. On the Spitsbergen Islands, north of Norway, the sun never sets during the summer months and the days are usually overcast, making it difficult to guess the time of day from the sky. Nineteen subjects—again, mostly graduate students—assisted in an experiment in this desolate region. Before arriving in Spitsbergen many of their rhythms, especially their excretory ones, had been studied at great length. Once in Spitsbergen, complete camping equipment was issued to the students, including sham watches, which ostensibly recorded standard 24-hour days, but which actually (and unknown to the subjects) measured out 21- or 27-hour "days."

Two camps, completely isolated from one another in uninhabited territory, were set up and the subjects, unaware of the timepiece subterfuge, were instructed to carry out their daily activities within the framework of time signaled by their watches. Their routine was interrupted every few hours to take oral temperatures and urine samples (in which potassium, sodium, chlorine, and water content were measured).

It should be pointed out that living within these abnormal time schedules meant that every eight 21-hour days were equal to seven real days; and every eight 27-hour days were equal to nine real days. Halfway through either set of eight experimental days the subjects were exactly 180° out of phase with real time—they were up and active at what would have been nighttime back home. The results of the six weeks' study were surprising.

The temperature rhythm of all but one subject adjusted quickly to the 21- or 27-hour days. Less quickly, the rhythms in sodium, chlorine, and water volume also locked into the artificial days. The potassium rhythm, however, seemed less susceptible to "deceit," and in most cases, maintained its 24-hour periodicity. While some of the body's rhythms can be made to operate according to time intervals of slightly more or less than 24 hours, others (the potassium rhythm for example) cannot. The results suggest that there is probably more than one living clock to control separate body functions, and furthermore, that the dependability of each is variable.

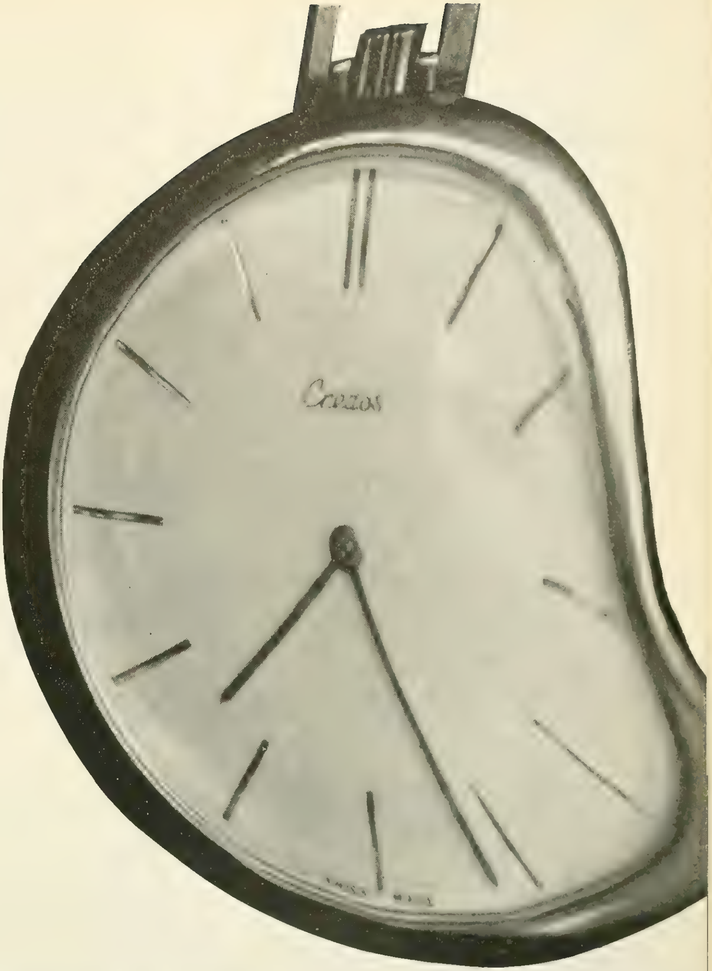
It is biologically necessary for a rhythmic process to be adaptable to change, for man is not sedentary in his habits, but moves restlessly over the face of the earth. Today, jet travel shaves hours off, or piles hours on, the length of a single day as travelers speed eastward or westward, and these geographic relocations place considerable stress upon one's living clock. For example, a person leaving New York at 6:30 P.M. will arrive nonstop in Rome at 8:30 A.M. (local time) just as this ancient city is awakening. However, the traveler's living clock is signaling 2:30 A.M. (New York time) and is informing him that it is time to retire. The clock must readjust to the new local time, and until it does, a person will not feel up to par. It is interesting to note that lack of immediate adjustment to new time zones was first observed in 1860 in an orangutan that was being shipped from Java to Germany. The crewmen noticed that the ape tended to maintain its Java sleep pattern in spite of the ship's westward movement through consecutive time zones. Unfortunately, the observations were cut short at the Cape of Good Hope when the animal died after drinking a bottle of rum.

The diplomatic services, large corporations, and athletic coaching staffs want their representatives to be in peak form when entering into business and competitive events in other countries, and a number of studies have recently been undertaken to this end. The procedure is simple but expensive: enthusiastic volunteers are flown from the United States to all parts of the world, and the rates at which their rhythms adjust to these new localities are measured. In addition to rhythmic processes, other assessments—reaction time, subjective fatigue, and decision time—are made on each subject before and after translocation.

After westerly translocations, for example, from Italy to the United States (crossing six time zones) or from the United States to Japan (ten time zones), subjects had to force their living habits to conform with the new local time. It was found that in general the various rhythms took five to six days to completely rephase to the new local times. Reaction and decision times were impeded, and fatigue was significantly increased the first day in the new location, but settled down to near normal by the second day. Older men showed higher fatigue levels than younger subjects.

On easterly flights—from Japan to the United States and from the United States to Italy—the rhythms rephased to local time much more rapidly: most were completely adjusted to the new local times by the second day. As with westward flight, reaction and decision times were impaired and the level of fatigue increased on the first day. North–south flights in which travelers remained in the same time zone had no effect on the biological rhythms, but again, fatigue was experienced after both outgoing and return flights.

The relative ease with which rhythms adjust after eastward flights as opposed to westward flights can be seen in the following example. A businessman traveling to Rome, and unaware of biological rhythms, would schedule his flight so that he could leave New York at a convenient time and arrive in Rome on the morning of the day of his appointment. He would therefore leave New York at 8:00 P.M. so that after an eight-hour flight he would arrive in Rome at 10:00 A.M. (local time), which corresponds to 4:00 A.M. of his own "body time." Biologically he should still be asleep; but he can force himself to carry out his business (with reduced efficiency, perhaps) and still engage in after dusk social activity there. By bedtime he will be quite tired; his own clock will be registering about 7:00 P.M. (it is already adjusting), and he will easily sleep through the remainder of the Roman night. On the other hand, suppose our businessman is with an Italian firm and must come to America. Leaving Rome at 9:00 A.M. would bring him into New York at 11:00 A.M. (local time) giving him time to conclude his first day of business and join in some social activities, but he will have to force himself to stay awake much of this time. He then tries to retire with New Yorkers just after midnight, but his biological clock is now signaling about 7:00 A.M. Roman time, which is his time to awaken. Even though he has been up for 24 straight hours (assuming he did not sleep in the plane) he now finds it difficult to fall asleep, for while it is easy to avoid sleep by a conscious effort, it is impossible to force oneself to fall asleep through mental persuasion. Thus, adaptation can be expected to require a longer time after a long westward flight than after an eastward flight.



Thus far I have described only a few of the rhythms known to exist in man—there are many more. The list includes pulse rate, blood output by the heart, circulating red and white blood cells, the amount of protein in the blood at any one time, circulating blood volume, blood pressure, the capacity of the lungs, cell division, a variety of psychiatric illnesses, the adaptation of the ear to new sounds, hormone secretions, the retention of memorized material, and about thirty or forty other rhythms. Surprisingly, even one-time or infrequent events in the human life-span also appear to be subject to rhythmicity. For example, the rate of childbirth is greatest between 2:00 and 7:00 A.M. and lowest between 2:00 and 8:00 P.M. (No wonder obstetricians often appear haggard.) Death rate is also highest between 2:00 and 7:00 A.M. Women tend to begin menstruation in the wee hours.

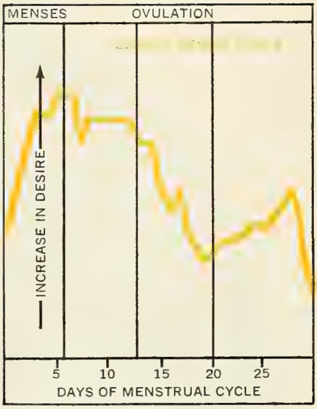
Another natural period on earth is the synodic-lunar month, the time between successive new moons. It is an interval of 29.5

days. There are many organismic rhythms—most of them reproductive cycles in lower marine animals—with periods of 29.5 days. For example, certain insects hatch out of their pupal cases into adults at the times of full moon. Summer egg production in the Mediterranean sea urchin is greatest at the time of full moon as was known by Aristotle, who recommended that gonad *aficionados* collect them at this time to obtain maximum enjoyment of the delicate ovaries.

That the moon was believed to have some influence on man is indicated by the reference to insanity as "lunacy." As it turns out there have been few scientific studies designed to examine the possibility of the effect of the moon on human life. Even the hint of interest in such an investigation would generate condemnation from fellow scientists, for one of the great triumphs of science in the past has been to abandon astrology and the notion that the movements of heavenly bodies in some way influence the lives of man. Some brave souls, however, in the interest of scientific inquiry, are willing to suffer ostracism by their colleagues and look for moon-related influences on human endeavor.

The human menstrual cycle, by its very name, implies a relationship to the month and moon. However, even elementary textbooks promulgate that the menstrual cycle averages 28 days (rather than 29.5—the number of days in a synodic-lunar month), and so ingrained is this belief that the eight and a half million women using the "pill," regulate their menstrual cycles to 28 days. Close re-examination of the data collected by earlier workers (the same data that produced the 28-day interval for the menstrual cycle) has now shown that the true average period of the human menstrual cycle is 29.5 days—the exact length of the synodic-lunar month. It was also found that the average gestation period—the time elapsed between the day of conception and delivery—was exactly nine lunar months (266 days).

Armed with this information it is now possible to count backwards 266 days from a birth date to learn the day of conception. By examining a large number of birth dates, then, it should be possible to learn if there is a synodic-lunar monthly rhythm in the time of conception. After statistically examining the birth dates of over a quarter of a million children born in New York municipal hospitals, it was found that the birthrate, and therefore the conception rate, is highest during the three days around full moon, which gives the "moon-spoon-June" ditty some scientific validity. An increase in conception rate at full moon suggests an increase in mating activity—a phenomenon seen in many lower animals.



Ecologists were quick to postulate that the added light reflected onto earth from the full moon must be the cause for the increased mating activity, although there is no proof of this. Nevertheless the newspapers made headlines of this "fact" nine months after "Black Tuesday" (November 9, 1965), the day the east coast of the United States was incapacitated by the pandemic power failure. It was amusingly reported that just nine months after the blackout, birthrates in the New York hospitals had increased. "Therefore," the newspapers proffered, "the ecologists are wrong, it is complete darkness that stimulates mating activity." The papers may have been wrong, for, as can be seen in photos taken that night, Black Tuesday was a night of full moon.

Scientists and others have always wondered if there might not be some sort of a rhythm in the human female's sexual desire. For years it has been tacitly assumed by the medical profession that the female desire for sexual union is greatest around the time of ovulation; however the little literature there is on the subject is a mixture of folklore and fact. Last year a study was done in an attempt to resolve this question. The greatest difficulty in carrying out the study was the selection of suitable subjects. All volunteers who were taking birth control pills had to be eliminated as were those who had undergone hysterectomies, those having intercourse regularly and thus often sated, those who were admittedly frigid, and those who "always felt like sex." The investigator finally assembled thirty women, who all had regular menstrual cycles and no regular sex life. In addition they were in psychotherapy and could be queried about their sexual feelings during each session with the psychiatrist. In this way a periodic desire for intercourse over 75 menstrual cycles was documented. The chart on this page shows that the women's libido was highest during the latter half of menses and during the period prior to ovulation. Other studies have shown that women also reach orgasmic climax more often around the middle of their menstrual month.

One of the most intriguing aspects of time-dependent processes is the rhythmic response of recipients to various toxins and medications. For example, if identical doses of bacterial toxins are injected into mice at various times of day, induced lethality is found to be rhythmic: 80 percent of the mice are killed when injected at 8:00 P.M. while less than 20 percent die from identical injections administered at midnight. Similar studies with ethyl alcohol caused death to 60 percent of a sample mouse population when the alcohol was administered at 8:00 P.M., while 20 percent died after 8:00 A.M. injections. Many drugs used on human beings come only in alcohol solution. Sodium pentobarbital, a commonly used anesthesia, was experimentally administered to rats and mice at different times of the day; injections given at night produced intervals of unconsciousness 66 percent longer in duration than identical doses given during the daytime. Damage caused by whole body X-irradiation has also been shown to be rhythmic, nighttime exposure being the most dangerous.

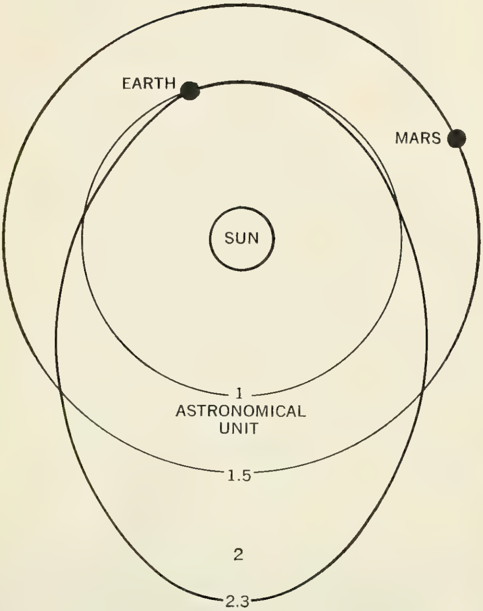
It has been shown that the allergic reaction in man varies with the time of day. Injection of common house dust just under the skin causes an inflammatory reddening and a welt, the severity of which is greatest after 11 P.M. injections, and least after 11:00 A.M. Many patients with asthma have more frequent attacks at night. Another study concerned itself with the length of time that aspirin continues to circulate in the blood. It was found that it remains in circulation a shorter length of time if taken at night, indicating that the analgesic benefits are prolonged when the medication is taken during the daytime.

Some of the most useful and relevant studies on the human living clock should come from the field of medicine. The discovery that the effect of some medications varies with the time of day could alter some of the basic tenets of therapeutic medicine and the test-screening procedures of new drugs. Unfortunately, the medical profession is far behind in the study of human rhythms. There are many questions that need answering in this area. For instance, should the heartbeat rhythm be taken into account before a heart transplant is attempted? Should not surgeons be sure that a donor's kidney is in phase with the excretory rhythms of the potential recipient? Is it wise to subject "evening people," whose temperature cycles and body processes do not reach a maximum until afternoon, to early morning surgery? Are their bodies in a state best able to survive at this hour? Should manned space shots be initiated early in the morning when most men's reaction times and work proficiency have not yet peaked for the day? Would not more world records be broken if athletes were aware of their body rhythms in performance efficiency? There is a great deal left to learn.

Because of the living clock's relentless activity, we are not the same person from one hour to the next; but at the same time each day, we are much like we were the day before and much like we will be tomorrow. Thus far, our studies of time-dependent processes in man are only in the initial, descriptive stages; we are discovering and describing more and more new rhythms. Unfortunately, as yet we have few concrete notions as to how the internal machinery of the living horologe actually functions. This mechanism must be deciphered because of its medical implications, because rhythmic behavior is a fundamental property of all life, and because of the insight it may provide into the personal and social functioning of our species.

Full moon over New York City during blackout, November 9, 1965.

SKY REPORTER



Meteor's calculated orbit extended beyond that of Mars. Its fall to earth was caught by an automatic camera at Hominy, Oklahoma.

Stars appear as trails because camera lens was left open as earth turned. A rotating shutter divided the meteor track into one-second segments.

The 22.6-pound meteorite, far right, was the first recovered by the Smithsonian's camera network. Richard McCrosky, at left, scientist-in-charge, examines it with Gunther Schwartz, network field manager, who found it on a road just half a mile from the predicted point of impact.

TRACKING A FIREBALL Last January 3 a piece of stone from the asteroid belt blazed into the earth's atmosphere at 35,000 miles per hour. It broke up over the central United States, spraying fragments over a section of eastern Oklahoma centered around Lost City, about 45 miles east of Tulsa. While a number of people saw the meteor move across the sky as a fireball, apparently no one witnessed the fall of any of the fragments.

The meteor's fiery passage was photographed by automatic cameras in Hominy, Oklahoma, and Pleasanton, Kansas, two of 16 unmanned camera stations that comprise the "Prairie Network" of the Smithsonian Astrophysical Observatory. The network was set up in 1964 in the belief that one or two fireballs a year would be tracked well enough so they could be found after landing.

None was found until January of this year, however. Working with the photographs from Hominy and Pleasanton, Smithsonian scientists computed the meteor's trajectory closely enough to say where it

should have fallen and where in space it had come from. Despite nine inches of fresh snow, the network field manager found a 22.6-pound fragment in the middle of a deserted country road just half a mile from the predicted point of impact. Snow had melted from around the object, uncovering a stony mass "like no other rock in the area," with a black, burned crust. Later a Lost City farmer searching a pasture for a lost calf found a second fragment, this one weighing ten ounces.

Working backwards along the trajectory, Smithsonian investigators found the meteorite had come from the asteroid belt beyond the orbit of Mars.

Why was this the first meteorite to be recovered in five years? Smithsonian scientists had expected to recover at least one a year, and the first months of network operation had revealed that fireballs are more frequent than had been thought. The answer appears to be that most fireballs are comet fragments: largely slush balls of ice and dust that vaporize completely before they hit the ground. There is other positive evidence for this view, in addition to the failure to recover meteors after tracking them; a meteor composed of ice rather than metal or stone slows down much more quickly when it hits the atmosphere, a characteristic revealed by the cameras.

The Lost City meteorite was only the second ever to be recovered by photographic techniques. One that fell near Pribram in Czechoslovakia in 1959 was recovered the same way, but the astronomers involved had not been specifically attempting a recovery.

Unfazed by the paucity of results in the United States and Czechoslovakia, the Dominion Observatory of Canada expects to complete its own 12-station network between Edmonton and Winnipeg by July. Alan T. Blackwell, project director, feels that bad luck may have been an important factor in the Smithsonian's failure to find a meteorite for five years. He says most authorities agree that at least 1,000 meteors a year make it to the surface on the land portions of the earth (only about 10 are found each year). If this number is valid, he argues, then the 250,000 square

miles covered by his cameras should yield an average of up to five a year. In choosing a site for their network, the Canadians, like their U.S. counterparts, chose a region in which meteorites would be relatively easy to find: comparatively flat land free of natural rocks. Blackwell is hoping that meteorites will not break the ice of Manitoba lakes but will remain on top, easily visible to a search party.

SLOW DOWN IN SPACE Cuts in the national space agency's budget are starting to show up in canceled or postponed plans. The schedule of lunar landings has been stretched out, primarily to save money, rather than to give scientists more time to evaluate the results of one trip before embarking on the next. The Apollo 20 flight has been scrapped. The 1973 instrument landing on Mars has been put off until 1975. A flight to Venus scheduled for 1973 is still on, but now only one spacecraft, instead of the original two, will make the trip.

No lunar landings at all are planned during 1972. Instead the first three-man crews will be flown to an orbiting laboratory to operate a large solar telescope. Plans to fly a 12-man space station as the first segment of an eventual 50-man behemoth, originally set for 1975, now appear certain to be postponed.

The budget cuts also mean less NASA money for academic research. This loss, together with the congressional directive to the Defense Department to stop paying for research not clearly related to military goals and the growing disenchantment with science on the part of politicians, may signal the start of a difficult decade for astronomers and space scientists.

MORE NAKED-EYE COMETS The last comet of 1969, discovered in South Africa on December 28, was expected to become a naked-eye object as it moved north through the sky during March. Known as Comet Bennett, it made 1970 a bonanza year for comet watchers, with three bright comets visible in just the first three months. During February, Tago-Sato-Kosaka faded as it moved away from the sun after having been as bright as magnitude 2.6 in January and having displayed a tail 10 degrees long, 20 times the diameter of the full moon. By the middle of March, Tago-Sato-Kosaka had faded to magnitude 9.4 as it moved north through Perseus.

During February, a comet discovered in Japan, Daido-Fujikawa, swung by the sun at a distance of just over six million miles, brightening to magnitude —3, nearly as brilliant as Venus at its brightest. Its nearness to the sun made it difficult to see, but one observer in Arizona reported at least 4 degrees of tail visible in binoculars on the morning of February 7, despite the light of dawn. On the 17th the comet passed within 10 minutes of arc of Venus, an apparent distance equal to about one-third the diameter of the full moon. Moving exceptionally fast, the comet was expected to be 150 million miles from the sun by April 15, when it would have faded to magnitude 15.

In March Comet Bennett became the third consecutive naked-eye comet of the year. Both the British Astronomical Society and the Central Bureau for Astronomical Telegrams in Cambridge, Massachusetts, estimated that Comet Bennett would brighten to at least second magnitude in March. During the month of April the comet was expected to be moving north through the constellation Pegasus. Predicted magnitudes were 2.4 on April 4, 3.8 on the 14th, and 5.1 on the 24th.

It could be a record year. Eight periodic comets, discovered on previous approaches to the sun, are expected to return during the balance of 1970. None is expected to become a naked-eye object, however. One, a comet called Encke, which returns every three years, will still be coming in toward the sun as the year ends, and should be brighter than ninth magnitude.

John P. Wiley, Jr.

Editors' Note: Because of the vagaries of mail delivery, we have decided to provide information on celestial events further into the future, beginning with this issue. The Star Map on the facing page would normally be published in the May issue; thus it is correct for 11:20 P.M. on April 1 and 8:30 P.M. on May 15. We are extending the Celestial Events column to 45 days, to cover the first half of May as well as all of April. Similar adjustments will be made in all future issues.

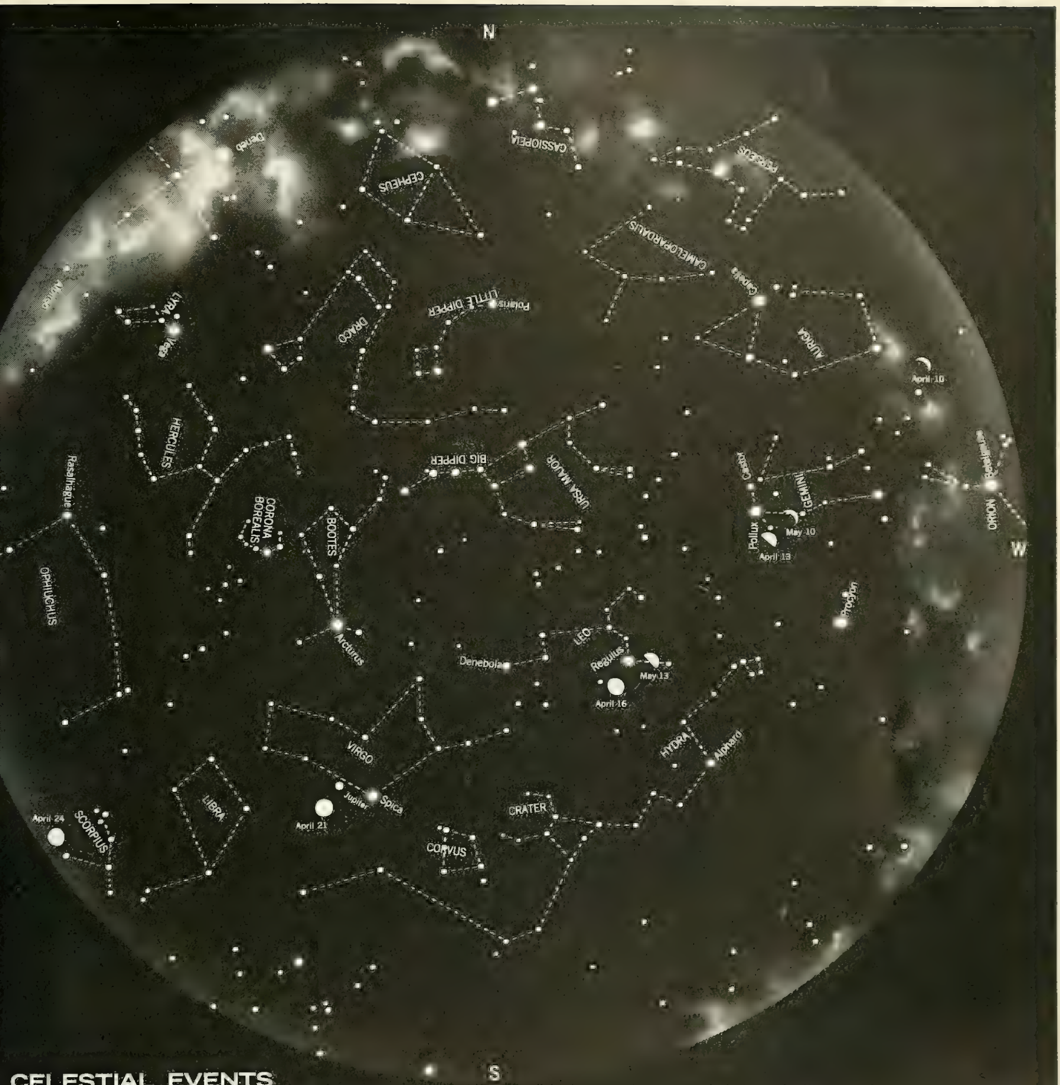
TWO IMPORTANT SKY EVENTS IN EARLY MAY

Transit of Mercury On May 9, the planet Mercury goes through inferior conjunction, coming between sun and earth. The path of the planet on that morning, as viewed from earth, will take it directly across the sun's face, and the planet will be visible as a black dot moving swiftly from left to right across the sun. Such an event is called a transit. Only Mercury and, more rarely, Venus can be seen in transit across the sun from earth.

The transit of Mercury on Saturday, May 9, will already be in progress at sunrise in eastern and central United States, and the planet may still be seen moving to the right across the sun. The planet will reach the point of egress (where it leaves the sun's disk) at about 7:10 to 7:13 A.M., EST, depending on one's location. Farther west, the transit will have ended by sunrise.

Occultation of Regulus The first-quarter moon passes between earth and the star Regulus, in Leo, on the afternoon and evening of May 13. Such an event, in which a star is temporarily hidden by the moon, is called an occultation. Regulus will be occulted during early evening twilight in eastern North America. The emergence of the star from behind the bright edge of the moon should be easily observed shortly after 8:20 P.M., weather permitting. Farther west, the occultation occurs in daylight.

T.D.N.


N
Deneb
CEPHEUS
CASSIOPEIA
PERSEUS
CAMELOPARDALIS
Capella
AURIGA
LYRA
Vega
DRACO
LITTLE DIPPER
Polaris
April 10
HERCULES
Rasalhague
BIG DIPPER
URSA MAJOR
Castor
GEMINI
Pollux
May 10
April 13
Betelgeuse
ORION
W
CORONA BOREALIS
BOOTES
OPHIUCHUS
Procyon
Arcturus
LEO
Regulus
May 13
April 16
Denebola
VIRGO
HYDRA
Alphard
LIBRA
Jupiter
Spica
CRATER
April 24
SCORPIUS
April 21
CORVUS
S

CELESTIAL EVENTS

In April, new moon is on the 5th, first-quarter on the 13th, full moon on the 21st, and last-quarter on the 28th. In May, new moon is on the 5th, first-quarter on the 13th.

Four planets are evening stars—Saturn, Venus, and Mercury low and close together in the west; Mars somewhat higher. Jupiter is in the east in early evening, setting in the west in the morning.

April 7-8: The early crescent moon passes above four evening planets. Saturn, Venus, and Mercury are in line below the moon on the 7th; Mars is above and to the left. All planets are below the moon on the 8th.

April 11: Venus and Saturn, with Mercury close by, are in conjunction in the western sky after sunset.

April 12: Mercury is in conjunction with Saturn. Bright Venus is almost between them; Mars is higher and to the left.

April 18: Mercury is at greatest evening elongation from the sun. The planet is easily seen as an evening star in the west for about a week before and after today.

April 21: Jupiter is at opposition from the sun. Look for it near the full moon tonight.

April 26: Advance clocks to daylight time.

May 2: Saturn enters the morning sky.

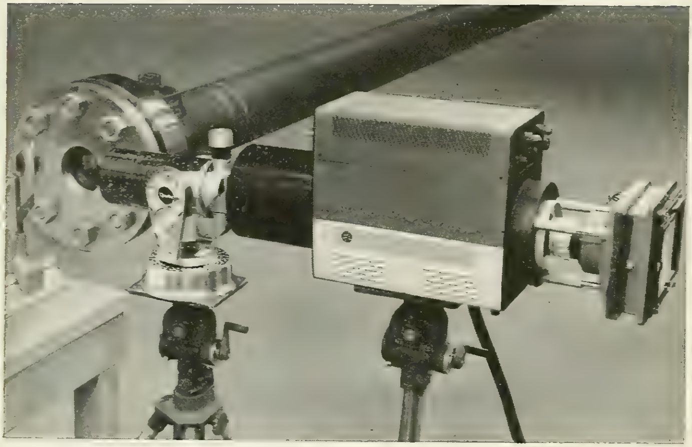
May 3-6: Mars, Venus, and the star Aldebaran, in Taurus, are close in the evening sky. Aldebaran is in conjunction with Mars on the 3rd; with Venus on the 6th.

May 6-7: Mars and Venus are to the left of the crescent moon on the evening of the 6th, closer to the moon and beneath it on the 7th.

May 9: Venus and Mars are in conjunction.

THOMAS D. NICHOLSON

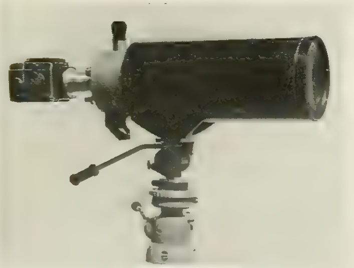
★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky. The map is for 11:20 P.M. on April 1; 10:25 on the 15th; 9:30 on the 30th; and 8:30 on May 15; but it may be used for about one hour before and after the times indicated.



QUESTAR PHOTOGRAPHS
HIGH-PRESSURE DIAPHRAGM OPENINGS

At NASA's Ames Research Center, three research scientists teamed up a Questar with an image converter camera to view a diaphragm through a window in the end wall of a shock tube. The image of the diaphragm is reflected into the telescope by an optically flat mirror at the end of the tube. The telescope's long focal length permits it to photograph the action and provide a relatively large image (about ½-inch diameter) of the 4-inch target located 40 feet away. The ICC transforms the optical image into an electron image, recreates the image at high intensity, and projects it onto photographic film.

Metal diaphragms act as quick-opening valves in shock-driven facilities, and the time of the opening is significant in the formation of the shock waves in the tube.



The Questar 7 with Rolleiflex FL-66 attached, mounted on the smooth-as-silk Miller Fluid Head with Lindhof Heavy Duty Tripod.

The method for viewing an opening diaphragm was developed in the Ames 30-inch electric arc shock tunnel, and the most satisfactory way to study the performance of a diaphragm is to photograph the actual process within the shock tube. However, with previous methods used, insufficient lighting, small size of image, and inadequate resolution could not produce a usable picture.

The arrangement devised by Robert E. Dannenberg, Dah Yu Cheng, and Walter E. Stephens, utilizing the 3½-inch Questar with its focal length of 1600 mm. and overall length of 8 inches, was employed for this application. The camera could record three frames of the event in rapid sequence with an adjustable, programmed delay between each frame.

The entire process is described in an article in the June AIAA JOURNAL.

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An introduction to the setting and cha
acters in the tragical farce or farcic
tragedy of Victoria Bluffs, S. C.

Continued from page 19

Opponents of BASF claimed tha
the study by a state agency woul
be a "whitewash." That charge wa
an insult to Guess and his "nation
ally recognized professional abilit
as a conservationist," Governo
McNair was reported as saying.

Guess is friendly, polished; har
dles questions easily. I do not re
call seeing a window in his plus
office. His first step, when the gover
nor tossed him the political ho
potato of the study, was to call i
his staff and outline the broades
approach. They suggested the follow
ing categories: physical, chemica
biological, economic, and sociologi
cal.

"That's a 10-year project," h
said. "And I haven't got a dime ye
to finance it. BASF has offered t
contribute, but I would rather no
take their money—unless I get a
equal amount from the opposition

"It's impossible to do all that. I
would take years. And ecology . .
you can get so bogged down tryin
to study it . . . ecology will kil
you."

Guess views his commission an
its pending study as "a cushion be
tween vested interests. You can'
satisfy everyone. Some people ar
going to charge that the study is
whitewash, no matter what we do
But you expect that kind of reac
tion. Many people are still worrie
about Christ, you know."

Mr. J. D. Little. Jr., director o
the South Carolina Developmen
Board, is one of the vested interests
that Guess must cushion. Little is
thin, dynamic, nervous man, whos
foremost concern is bringing in
dustry to the state. Last year, new
and expanded plant expenditures
totaled $706 million, well above the
previous year's record of $636 million. The BASF investment—$10
million initially, possibly anothe
$100 million for a petrochemical
facility, with hints of an ultimate
figure of $400 million—is an important part of the state total.

"Water is an economic resource," Little stated, "and it is up to the people of the state to determine what they want to do with it."

He pointed out that the state has always accepted a degree of water pollution for economic benefits. Pulp mills are one example. "We don't like the smell, but it smells like money," Little said, pleased with his phrase.

"And don't forget, there's a lot of natural pollution, like swamp water."

For Jay Little, the issue of environmental protection could hinder his drive to bring industrial development to the state. He believes that the tidelands are ripe for an economic boom, and that BASF picked the Victoria Bluffs site because all the better deepwater sites for a wet industry had been taken. In Little's opinion, South Carolina's depressed, underdeveloped coastal region has become a great asset because, at a time when other states are beginning to run out of large tidewater sites, it still has vast areas that are excellent for industrial development.

The fate of the salt marshes, of all that polluted swamp water, of the estuary ecosystems are, for him, a minor matter when compared to the benefits of development.

Dr. H. J. Webb's heavy frame, sagging in a swivel chair behind his paper-smothered desk, was in sharp contrast to Little's. It was late and Webb, associate director and designated future director of the South Carolina Pollution Control Authority, appeared tired.

Mixed in among the other papers on the desk was a subpoena that had upset his whole day. It demanded that the agency explain in court why it had not properly monitored the effluent of the Tenneco plant and why it had not canceled the plant's permit to discharge waste. With the legal document was a pile of worked-over notes and maps prepared for a discussion of the case with the attorney general's office.

The subpoena was a new type of problem, a new tactic by conservationists to protect the tideland environment. Webb, whose authority is responsible for policing both air and water pollution in the state, looked like an unwilling draftee in the escalating war to save the environment.

"The authority only has 48 authorized employees for the whole

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state," Webb said. "We've asked for 87 new positions in the next budget. That would include 39 new field people in water alone."

Webb believes that the state's pollution control law, which he helped draft, is a good one. The main problem is a staff too small to adequately police the potential polluters. Unless the authority gets most of the new positions it requested, the natural environment of South Carolina will be without a watchdog, in constant danger.

Columbia, the capital of South Carolina, is in the hills of the Piedmont, overlooking the state's coastal plain, or lowlands. From those heights, the state's officials, McNair, Guess, Little, Webb, and many others, seem to view the Hilton Head Island-BASF dispute as a local skirmish, as a contest between several pieces on a chess board. BASF, with its financial power, is a rook, the island developers are bishops, and then there are pawns that are hardly noticed. Yet a pawn can decide the game.

The rook, the BASF Corporation, is confident how the game will end. Dr. Lautenschlager, in his 30th-floor corner office in Manhattan, outlined the schedule: detailed topographic studies and test borings this spring, ground-breaking by the fall, the first plant in operation—its output on-stream—by the fourth quarter of 1972.

BASF chose the Victoria Bluffs site because there was "enough room"; because the labor supply and traffic connections to the southern textile and furniture markets were good. The state officials were cooperative, but "we did not get any unusual concessions." They had looked at many places: Clinton, Iowa; on the Ohio River; along the Gulf Coast; but none had all the advantages of the Beaufort County location.

Lautenschlager repeated his pitch about environmental protection, about modern pollution controls that would cost at least $2½ million, about plans to leave a greenbelt of trees along the highway. "We will be a good neighbor. I think people will be surprised. We plan to make this a model plant, an example for all industry. Perhaps people someday will thank us."

Dr. Lautenschlager is a physical chemist, not a biologist or an ecologist. He still talks about an "ecological survey" as though a scientist could, over a short period, count the organisms and measure the physical conditions of the Colleton River, and from that define the local ecosystem. He has yet to gain the wisdom of Mr. Guess that "ecology can kill you" because of its complexities and dynamics.

"Wait and see," he said, sensing my skepticism. "We will have a pool next to the plant, filled by the treated effluent. We'll have live fish in the pool. Then will you believe me?"

"I'll wait and see." I thought later that I should have asked him, "What kind of fish . . . sea trout or carp?"

As usual, I held some of the unpleasant questions until the end of the interview. "Some of your opponents at Hilton Head believe that if they can delay your construction for one or two years, so that your product would not be able to go on-stream until 1974 or later, you would build elsewhere. Is that true?"

The frown, the long pause, and Lautenschlager's reply that he did not think it would be possible to delay the plant, but that a delay could be a problem, all confirmed my intuitive feeling about the importance of one of the pawns at Hilton Head Island.

William F. Kenney is one of the retired, small-lot residents of the island. He is part of a citizens' group, many of them northerners, called the Hilton Head Island Community Association, that has become increasingly active in opposing the BASF project.

When he retired as a vice-president and general counsel of Shell Oil Company last year, Kenney made several radical changes in his life. He moved from New York to an oceanfront home on Hilton Head Island. He stopped wearing a watch. And, after 29 years of advocating the rights of an oil and chemical company in legal battles, he shifted to the other side.

Because of his long experience in legal matters against conservationists ("I have never lost a case"), Kenney is probably one of the most realistic and effective opponents of the chemical plant com-

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plex. He acknowledges a selfish motive: "Most of us on Hilton Head moved here to get away from industry and pollution." But he also believes that Beaufort County will lose more—in public expenditures, tax revenues, job opportunities, and resources—than it will gain from the BASF project.

When he first joined the efforts of the Hilton Head Island Community Association to oppose BASF, Kenney felt the group did not have a chance of winning. Now, after months of maneuvers, after trips to Washington, after close scrutiny of all the applicable laws, Kenney believes that the chances of stopping BASF are about one in four.

Kenney sees a need for two kinds of tactics: short-run legal maneuvers to delay construction of the BASF facilities and long-run efforts to shift public opinion.

For the short-run legal tactics, Kenney has found several possible precedents, including part of the Rivers and Harbors Act of 1890, that may be effective in delaying construction. There is even a slim chance, he believes, that BASF might build elsewhere if they faced a one-to two-year delay because of legal action. However, the long-run struggle is far more important:

"We must never lose sight of the fact that our opponents are the public officials, not BASF. As long as the public officials want the firm, there is almost no chance of stopping it. On the other hand, if the public officials changed their minds and decided they did not want the plant, the company would not build, even if it had the legal right to do so. No company will move into a state where the government is hostile to it. The only way to change the opinion of the government is to arouse enough public opinion against the plant. Legal action may give us the time we need to reach the public."

If Kenney's analysis is correct, and I think it is, then the battle to save the Colleton River estuary in Beaufort County or the tidelands of South Carolina or the natural environment of the United States is a battle for the minds of the pawns: the American public who, by their concern or by their apathy, will determine the future environments of the United States. ■

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Books in Review

Mission Impossible: A Humane Science

by Spencer Klaw

REASON AWAKE: SCIENCE FOR MAN, by René Dubos. *Columbia University Press, $6.95; 280 pp.*

Scientists are in trouble in America today. More and more people are questioning the relevance of science to the betterment of human life. Scientists are being bitterly reproached by their own students, among others, for the immoral and antihuman uses to which their work is put. In Washington, too, there is disillusionment. Federal patronage, which has had so much to do with the spectacular flowering of American science since World War II, no longer flows in such copious streams. Professors of physics or biology who used to complain, half-seriously, that American scientists were eating too high on the hog are now hard pressed to find the money to keep their own laboratories running.

There are scientists who blame their difficulties on the public's imperfect understanding of science and its limitations. This view is sharply challenged by Prof. René Dubos of Rockefeller University, who argues that scientists have largely forfeited the right to the respect of their fellowmen. They have successfully claimed the support of society, he points out, on the ground that great material benefits will inevitably spring from their work. And having proposed this bargain, scientists can not then honorably disclaim responsibility when the promised benefits fail to appear—or when the fruits of their work are used to degrade the environment of man and man himself. "As the power of science increases," Dubos writes, "its uses become less sacred, more trivial, more brutal, and often more immoral. Scientists are not entirely responsible for this desecration, but we have done little to prevent it. As a community we have betrayed our ideals by . . . promoting our wares through irresponsible promises to society of perfect health, economic prosperity, and military power."

Reason Awake is a plea and a brief for a more human science, a science guided by a determination to help men realize their highest potentialities. This is a plea more often advanced by nonscientists than by scientists themselves. Knowledge is best pursued, scientists are apt to argue, when the pursuit is seen as an end in itself, and a science guided by external considerations—even so noble a consideration as the welfare of mankind—is necessarily a mediocre science. Dubos, however, whose earlier books include a biography of Louis Pasteur, is not only a thoughtful and sophisticated student of the history of science. He is also a distinguished experimental scientist, who has turned from microbiology to the study of how animal development is affected by environment.

The heart of Dubos's argument is the contention that science and its applications have become so closely coupled over the past 150 years that "pure" science has lost such meaning and virtue as it may once have had, and that scientists must therefore accept responsibility for the consequences of their work.

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Many scientists these days accept this responsibility in principle, Dubos observes, but too few are prepared to do much about it. As a case in point, he recalls that soon after the publication of Rachel Carson's *Silent Spring* President Kennedy appointed a blue-ribbon committee to advise him on the pesticide problem. "All the members of this committee," Dubos writes, "were eminent biologists who held influential faculty posts in great universities. Their report confirmed facts that had been long known by anyone familiar with the field, and it also emphasized the need for further study." Nevertheless, Dubos continues, "there is no indication that any member of the committee did anything to encourage his staff or graduate students to work on pesticide toxicity. Nor is there any evidence that the committee has fostered such research in other institutions during the several years that have elapsed since the preparation of the report."

Dubos adds bitterly, "Membership in a blue-ribbon committee or a task force is at best a form of sublimation that provides a glamorous substitute for becoming involved in the practical affairs of the world."

If man is to save himself from the consequences of his own technological prowess, Dubos argues, gifted scientists will have to give up the luxury of pure science and immerse themselves in the difficult and complicated business of finding ways to use science beneficially. This will require, he says, a migration of scientists from the universities to research institutes of a new kind, organized for the purpose of bringing to bear on a particular social problem—the effect of environmental factors on human emotions, for example—the resources of a number of different scientific disciplines.

Dubos concedes that a scientist who leaves the university for a "mission-oriented" laboratory sacrifices some of his freedom to choose research problems purely for their intrinsic scientific interest. And he recognizes that the climate of large, applied-research laboratories has not always favored initiative and creativity. But he is confident that this need not be the case, provided that scientists are encouraged "to become intimately involved in the formulation of the social objectives to which their work will contribute."

This summary of Professor Dubos's central thesis does not suggest the scope and texture of his engagingly discursive essay. Although Dubos, at sixty-nine, often sides with the angry student critics of the scientific establishment, his mode of discourse is characterized less by anger than by a grave and luminous rationality. Here, by way of illustration, are his thoughts on a few of the matters he dwells or touches on:

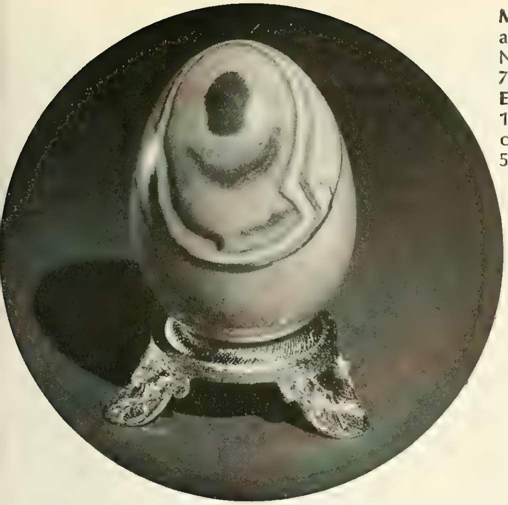
On Science and Beer: "Some of the factors that affect the direction of the scientific effort are rather unexpected. It has been suggested, for example, that the practical problems posed by brewing practices greatly stimulated the early development of science in Europe. The process of converting barley into beer involved physicists in the problems of gas pressure, chemists in the structure of starch, enzymologists in the study of yeasts and bacteria."

On Intellectual Escapism: "Scientists find it much more entertaining to talk about such a far out possibility as the manipulation of the genetic code, than to concern themselves with the control of lead poisoning, a childhood disease which is a social crime of today."

On the Futility of Countertechnologies and "Technological Fixes": "Developing countertechnologies to correct the new kinds of damage constantly being created by technological innovations is a policy of despair. If we follow this course we shall increasingly behave like hunted creatures, fleeing from one protective device to another, each more costly, more complex, and more undependable than the one before. . . ."

On the Need for a Higher Criticism of Science: "A society that blindly accepts the decisions of experts is a sick society on its way to death. The time has come when we must produce, alongside specialists, another class of scholars and citizens who have broad familiarity with the facts, methods, and objectives of science and thus are capable of making judgments about scientific policies. Persons who work at the interface of science and society have become essential simply because almost everything that happens in society is influenced by science."

On Why There Is Ground for Hope: "In an inspired passage in *Science and the Modern World*, Whitehead suggests that the order of nature as conceived by scientific determinism has now taken the role of Fate in the Greek tragedy. . . . Fortunately, the *applications* of science to human affairs do not have so high a degree of inevitability as do the laws of nature. Contemporary man seems to be poised between passive acceptance of scientific technology for its own sake, violent rejection of it, or conscious use of it for some ultimate concern. The social ferment which is beginning to agitate the



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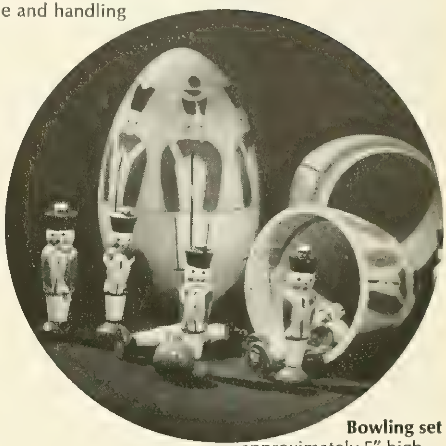

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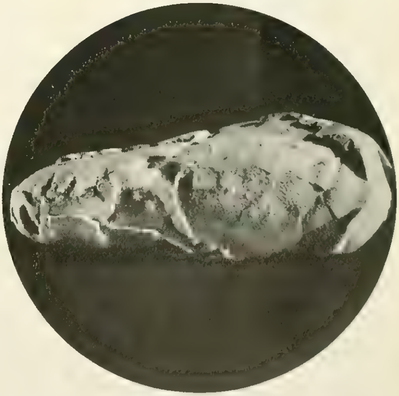

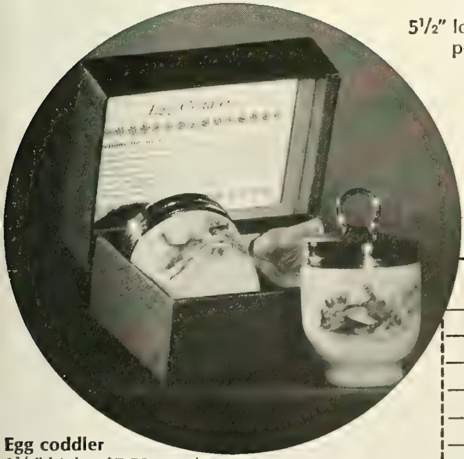

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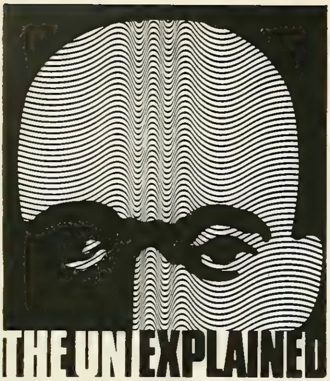

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Arthur C. Clarke, author of "2001," comments. Startling probes include the mysteries of space, hypnosis, ESP, the human brain, animal communications, plant behavior and other unexplained phenomena.

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community of scientists gives hope that man still has a chance to control his destiny by imposing a direction on the scientific endeavor and, in particular, by consciously planning the scientific technology that will shape the modern world."

Spencer Klaw is the author of The New Brahmins: Scientific Life in America. *A former editor of* Fortune, *whose articles have also appeared in* Harper's, Esquire, *and other magazines, Mr. Klaw now teaches a course on environmental reporting at Columbia University.*

The American West: A Natural History, by Ann and Myron Sutton. *Random House, $20.00; 270 pp., illus.*

Not all "beautiful books" are worth $20. This one is. The text is by two of the most experienced and technically capable outdoor interpreters in the land. Both the superb color and black-and-white photographs, well keyed to the text, are by some of America's leading camera artists, including Ansel Adams, Josef Muench, and Eliot Porter. It is an ambitious chore to prepare a book that encompasses a description of the natural history of the entire western region from the Mexican border to, and including, Alaska. The authors have walked many of the trails themselves and have used expert judgment in selecting not only the high spots but also many areas that often escape attention in lesser works.

Of particular interest are the fascinating accounts of the origin and development of various geologic features, the life they supported in bygone eras, and the plant and animal life that inhabit them today. The authors have been careful to place first things first throughout this large-sized volume (ten by twelve inches) by providing adequate background material before introducing the more obvious aspects of everyday observation, as they take the reader from one remarkable region to another. The text could easily stand by itself, and this is indeed high praise for a book of this nature.

A rounded ecological approach is used in practically all references to wildlife and plant life—both individual species and the broader aspects involved in populations as a whole. A high degree of objectivity is apparent in these descriptions, especially where the so-called predator species are concerned. There are no bird or mammal villains in this book, although there are passages that tell of unfavorable results from certain forms of overprotection as well as from lack of protection. The geographic distribution of plants and animals receives satisfac-

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tory attention and, here again, the whys and wherefores underlying environmental conditions essential for species survival are stressed. In effect, the authors say, "Take a good look at this animal, this plant, or this geologic formation before going on to something else." This is the way it should be.

One cannot read this book without gaining a renewed appreciation of the great heritage that is ours in the still wild places of the American West. By the same token one cannot but become newly aware of the serious threats that face many of the regions under consideration, especially the threats imposed by ever increasing human population pressures upon the often fragile wildlife and plant life ecosystems that make this life possible. In the book's concluding paragraph the authors express themselves in relation to future prospects for wildlife in Alaska: "If a love of nature prevails in the hearts of men and they hear in the voice of the crane an echo of the past and a song of the future, these men will have approached the kind of maturity that stewardship of the land requires. And if by listening to the music of a mountain stream and the gentle rustling of cottonwood leaves they find their vision enlarged and their burdens lifted, then the West has been won and its greatness will endure." This handsome book will certainly enlarge one's vision, too.

William H. Carr
Arizona-Sonora Desert Museum

Great Botanical Gardens of the World, by Edward Hyams and William MacQuitty. *The Macmillan Company, $35.00; 288 pp., illus.*

This profusely and beautifully illustrated work is the commendable production of two talented Britishers, Edward Hyams, a veteran author of garden books, and William MacQuitty, a Fellow of the Royal Geographical Society and a noted photographer and film producer. It must have been truly frustrating to select just fifty great botanical gardens from a possible 525 (listed with their addresses at the back of the book—a most useful compilation taken from the *International Directory of Botanical Gardens*). This reviewer feels grieved that The New York Botanical Garden, in the Bronx, is dismissed with the brief comment that "while it is true that the research staff of the Bronx Garden is engaged in the most advanced scientific work—notably in molecular biology—being done in any American botanic garden, the garden itself is very inferior to the Brooklyn one." May I state that in addition to its "advanced scientific work" The New York Botanical Garden continues to hold a foremost place with its elemen-

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- North Sumatra; The Batak tribes and their villages around Lake Toba.
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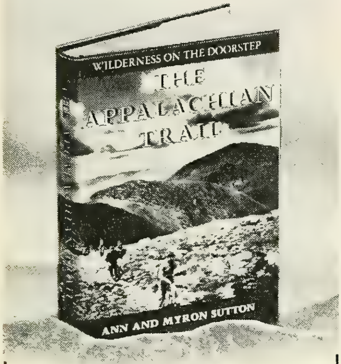

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tary and advanced training courses in botany and horticulture. However, the vastness of the contents of this present work under review cannot be easily overlooked. Hyams and MacQuitty toured almost the entire world, interviewed the directors and prominent members of the staffs of countless institutions, absorbed their history, learned of their current projects and activities, and obtained copies of plans, prints, paintings, and photographs of numerous gardens and individual plants. Twenty-four countries are represented, and the subjects range from the sixteenth-century gardens of Padua and Pisa to the new botanic garden at Meise near Brussels with its very modern Palace of Plants—the largest greenhouse in the world.

There are many facets of interest throughout this book: biographical notes on botanists, horticulturists, landscape gardeners; historical data on plant introductions and plant hybridization; illustrations of natural features in landscape design and of unusual collections of specific groups of plants. Frequently we find references to garden publications that are available for further study. Some of these botanic gardens, such as those at Singapore and Peradeniya, founded primarily to serve as acclimatization stations and trial grounds for economically valuable plants, occupy an important place in the world history of foods, condiments, and textiles. The policy of others, like the Royal Botanic Gardens at Kew and Munich's Botanische Staatsammlung, is not only to serve scientific botany but also to attract the general public to their gardens of ornamental plants and collections of exotic flora. Several of the gardens described were originally created for wealthy individuals, ardent amateur plantsmen who provided that after their deaths their magnificent estates be forever open to the plant-loving public. Fine examples of these are the Longwood Gardens at Kennett Square, Pennsylvania, of Pierre S. du Pont; Villa Taranto on Lake Maggiore, of Captain Neil McEacharn; The Fairchild Tropical Garden on the outskirts of Miami, Florida, of Col. Robert Montgomery; and the Huntington Garden at San Marino, California, of Henry Edwards Huntington.

It may surprise some people to learn that the USSR has many more botanic gardens than any other country in the world and that "the Nikitsky Botanical Garden is not only one of the most interesting of the gardens described in this volume; not only one of the most active in the fields of botanical science and economic botany; it is also one of the most beautiful."

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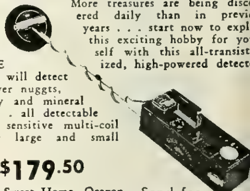

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nformation there are bound to be ninor errors and omissions. I notice hat the first director of the Arnold rboretum is given as James Sprague argent instead of the correct Charles prague Sargent. Omitted in the index re the names of several directors of nstitutions that are mentioned in the ext—Russell Seibert of Longwood ardens; Harold Fletcher of the Edinurgh Botanic Garden; Richard Howrd of the Arnold Arboretum.

However, because there is so much o praise in this truly fine work, we are reatly indebted to author Hyams and hotographer MacQuitty for presentng so magnificently, within the covers f one volume, this treasury of botanial and horticultural endeavors and ccomplishments.

ELIZABETH C. HALL
The Horticultural Society of New York

INCE SILENT SPRING, by Frank Graam, Jr. *Houghton Mifflin Company, 6.95; 333 pp.*

Mr. Graham provides a comprehensive and responsible review f "hard" pesticides from the time heir ecological effects were first oberved down to the present moment. The end of the story, of course, beongs to the remote and "iffy" future.

The problem was brought into harp focus for the first time by *Sient Spring,* the book that Rachel arson did not want to write. Turnng from more congenial literary rojects with a sense of obligation nd urgency, this gifted and very priate person knowingly took on a host f enemies: the agricultural hierrchy—from the United States Deartment of Agriculture down to the tate- and county-agent level—food rocessors, the mass media, the chemcal industry, and the professors who ad entered into a comfortable sweeteart relationship with the manufacurers of DDT compounds.

But *Silent Spring* accomplished its urpose. It synthesized the issue of he persistent pesticides and the hain of life. With the appearance of he book in 1962, the subject was beore the larger public, which ultinately determines social goals. Yet he squirt-gun mentality continues to oom large in Mr. Graham's lucid ages as he weaves together the trands of evidence against the indiscriminate use of the chlorinated ydrocarbons for pest control. It is nstructive to learn, for example, that s late as 1961, an assistant secretary f agriculture assured Congressman ohn V. Lindsay that no new legislaion was needed to protect the public rom environmental pollution. The dialogue was frequently frustrating.

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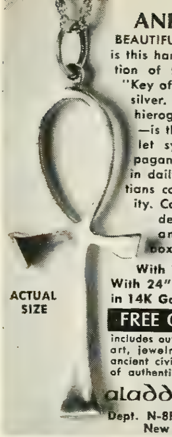

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The friends of the earth talked about life. The friends of DDT talked about money. Control had become an end in itself, so that we had, and still have, the extraordinary phenomenon of wildlife agencies largely devoted to Compound 1080 and the extermination of wildlife.

The author, a well-known writer on conservation topics, concludes his survey by citing certain recent developments that suggest there may be "A Light at the End of the Road." They derive from a breakthrough in hormone research and advanced techniques in biological controls that may—emphasize *may*—help us to maintain a saner relationship with the environment than the kind of management provided by the DDT sprayers. Meanwhile, the political process is catching up. Last year Michigan became the first state to outlaw the sale of DDT, followed by Arizona, California, Florida, Maryland, Washington, and Wisconsin. Aerial spraying is banned in Connecticut, and there are signs of movement in the ponderous bureaus of official Washington, where it has been decided to phase out the use of persistent poisons over a period of two years. (Except in some cases!) The rest of us will be well advised to remember that the problem is not going to go away, and to continue to follow the directions on the label, especially the part in small type where it says, "Buyer assumes all risk."

Gerald Carson
Author

Prehistoric and Primitive Art, by Luis Pericot-Garcia, John Galloway, and Andreas Lommel. *Harry N. Abrams, $25.00; 340 pp., illus.*

The authors of this handsome volume make it clear that we can respond to and evaluate the arts of Stone Age man and of the tribal cultures of Africa, the Pacific Ocean basin, and North American Indians even though they are so exotic to us. However, while we can intellectually grasp some of their symbols and meanings, we cannot directly experience, and therefore cannot understand, the compulsions that forced prehistoric and primitive peoples to create what they did the way they did.

Pericot-Garcia has the most difficult task for, historically speaking, there is no way of our ever knowing what caveman meant by his art, but he provides a guide to those sites that have yielded evidence of the arts of Stone Age hunting and fishing communities and early agricultural peoples. He accepts (with some reserve) the theory, popular since the nineteenth century, that cave art was an expression of the sympathetic magic used to insure success in the hunt. In the past few decades this position has come under attack; many cultural historians have suggested alternate, equally persuasive theories growing out of recent developments in psychological and psychoanalytic thinking. For example, it has been suggested that the major role of Upper Paleolithic art was to relieve by symbolic action the tensions and anxieties created by the dawning awareness of man's identity in an alien and frequently hostile environment (*see* "The Baton of Montgaudier," Natural History, March, 1970).

On the basis of present evidence Pericot-Garcia also accepts the theory of a single epicenter of prehistoric art—western Europe—from which it spread worldwide. This diffusionist approach to cultural innovation is, of course, disputed by proponents of the idea that simultaneous invention of similar patterns in different parts of the world is possible and probable.

The other two authors have a somewhat easier task, for they chronicle cultures that are closer to us in time, and for which there are still remnants of oral tradition more or less untouched by European influence. Thus, they can speak with some degree of assurance of the manifold functions of art within the several cultures: social, political, magical, cultic, funereal, sexual, etc. Professor Galloway surveys the continents of Africa and North America, describing the arts of the major tribes and ethnic units. Lommel covers the Pacific Ocean, an area so diverse in its ethnic composition that he describes the arts, not by cultural groups, but by major design motifs.

It has long been obvious that the tribal arts of the world collapsed before the onslaught of Western culture; those artificially stimulated "folk arts" that remain are forced imitations of earlier crafts. And it should be equally obvious that citizens of the modern world can never go back to primitive cultures, mores, traditions, styles, or patterns. Links with the past can never be reforged (as an unscientific American author intuitively knew when he said that "you can't go home again").

An interesting thought emerges from a reading of this excellent survey. Prehistoric and primitive arts are related to each other but different in kind from that of the complex Oriental and Western cultures, which, in turn, are different in style but related in kind. Is the difference that of literacy? There is the interesting coincidence of highly stylized symbolic art

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of nonliterate peoples giving way to naturalistic narrational art when writing is introduced. The invention of writing may have had more profound effects on the visual arts than we have hitherto supposed.

BERNARD GOLDMAN
Wayne State University

Briefly Noted:

INTERNATIONAL ZOO YEARBOOK 10, edited by Joseph Lucas. *The Zoological Society of London, $21.00; 373 pp., illus.*

The tenth volume of this excellent series contains twenty papers on owls and other birds of prey in captivity; a section on new developments in the zoo world; and a full list of the world's aquariums, bird parks, and primate research centers. The *Yearbook* provides zoo people, conservationists, and biologists with the opportunity to keep up with developments in the zoological world, but is also an indispensable source of knowledge for anyone interested in the behavior, conservation, and care of wild animals. The text is accompanied by 52 high-quality, black-and-white photographs.

THE WORLD OF THE GIANT PANDA, by Richard Perry. *Taplinger Publishing Co., Inc., $7.50; 136 pp., illus.*

After covering the world of the tiger, walrus, and polar bear in previous books, Richard Perry has turned his sights on perhaps the most appealing mammal of all—the giant panda. The book is a fine compendium of information drawn from numerous historical records and from Mr. Perry's own observations of captive animals. The illustrations consist of many excellent close-up photographs of these sad-eyed animals plus charming drawings by Wolfgang Weber.

C.B.

INTECOL BULLETIN, *International Association of Ecology, semiannual, $3 a year.*

Published by the newly formed International Association for Ecology, this bulletin is designed as a forum for news of research, requests for information, reports on activities of national ecological societies, suggestions for conferences, and almost any other news of interest to ecologists. The association hopes to become the voice of world ecologists, able to advise governments and international agencies. Details on the bulletin and the association are available from the Secretary General, Institute of Biology, 41 Queens Gate, London S.W.7, England.

J.W.

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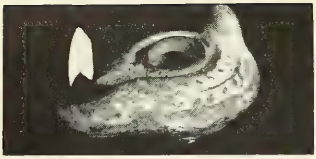

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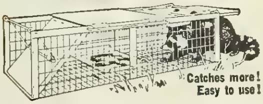
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40-43—Helmut Wimmer
44-51—Robert Edwards except map, AMNH and 50—bottom, Maxine Eastman
52-58—Tom Page except charts, AMNH after Palmer
59—Time-Life
60-61—Smithsonian Astrophysical Observatory
63—Helmut Wimmer
68-69—UPI Photo

To our readers:

Errors were inadvertently introduced in the subtitle and captions for the article, "The Baton of Montgaudier," by Alexander Marshack, which appeared in our March issue. We are printing corrections below in exactly the same size and form as the original; readers should clip them and paste them in the proper places in that issue.

Subtitle, page 57:

Reindeer hunters living in France more than 12,000 years a discriminated season, sex, and age when they engraved plants and animals on pieces of antler. Some images hint at sophisticated system of abstract representation at least 8,000 years older than what had been considered the oldest example, the picture writings of Mesopotamia and Egypt

Caption, page 58:

Photographic enlargement and line drawing of engraved salmon reveal open mouth and hooked kipe, indication that the fish was a male in the season of spawning.

Caption, top of page 61:

These engravings near the bottom of the baton appear to be plants in full leaf. Theories of Ice Age hunting magic had given rise to the concept that these were barbed weapons.

Caption, bottom of page 61:

A more schematized ibex head also seems to have been crossed out, this time by two separate lines.

Caption, bottom of page 63:

For years, this image defied description. Under the microscope it appears to be a flower in bloom—complete with pedicel, sepal, leaves, and petals.

NATURAL HISTORY regrets these errors. The author writes: "Because of the new concepts and methodology reported in the article, the errors in captions and subtitle are probably understandable. I do hope that the general reader as well as the specialist will also avoid making too hasty interpretations or reinterpretations from the data, for this is a new field and it will be years before the full significance of the research is realized."

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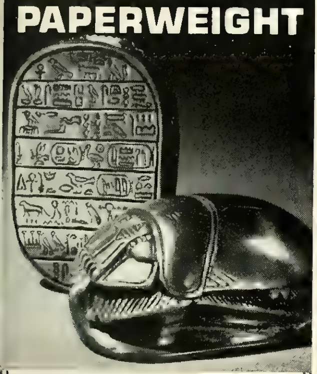

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A SYMPOSIUM ON ESTUARINE FISHERIES. American Fisheries Society, Special Publication No. 3, 1966.

THE WILDLIFE WETLANDS AND SHELLFISH AREAS OF THE ATLANTIC COASTAL ZONE. G. P. Spinner. Folio 18, Serial Atlas of the Marine Environment, American Geographical Society, New York.

A STUDENT MANIFESTO ON THE ENVIRONMENT

FUTURE ENVIRONMENTS OF NORTH AMERICA. F. F. Darling and J. P. Milton, eds. Natural History Press, New York, 1966.

A SAND COUNTY ALMANAC. A. Leopold. Oxford University Press, Inc., New York, 1966.

EAST IS A BIG BIRD

LAMOTREK ATOLL AND INTER-ISLAND SOCIOECONOMIC TIES. W. Alkire. University of Illinois Press, Urbana, 1965.

THE EASTERN CAROLINES. J. L. and A. M. Fischer. Taplinger Publishing Co., Inc., New York, 1957.

BARNARD'S STAR

WE ARE NOT ALONE. W. Sullivan. McGraw-Hill Book Company, New York, 1966.

EXPLORATION OF THE UNIVERSE. G. O. Abell. Holt, Rinehart and Winston, Inc., New York, 1964.

MODERN ASTRONOMY. D. S. Birney. Allyn & Bacon, Inc., Boston, 1969.

PREHISTORY DOWN UNDER

THE WORLD OF THE FIRST AUSTRALIANS. R. M. and C. H. Berndt. University of Chicago Press, Chicago, 1965.

YIWARA. R. Gould. Charles Scribner's Sons, New York, 1969.

THE MANY CLOCKS OF MAN

TIME MEASUREMENT IN PLANTS AND ANIMALS. F. A. Brown, J. W. Hastings, J. D. Palmer. Academic Press Inc., New York, 1970.

SLEEP AND WAKEFULNESS. N. Kleitman. University of Chicago Press, Chicago, 1963.

THE PHYSIOLOGICAL CLOCK. E. Bünning. Academic Press Inc., New York, 1964.

HEART POISONS AND THE MONARCH

MIMICRY IN PLANTS AND ANIMALS. W. Wickler. McGraw-Hill Book Company, New York, 1968.

ECOLOGICAL CHEMISTRY. L. Brower. *Scientific American*, February, 1969.

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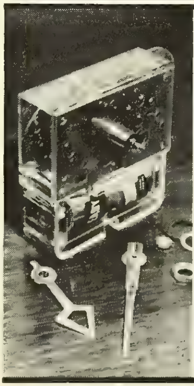

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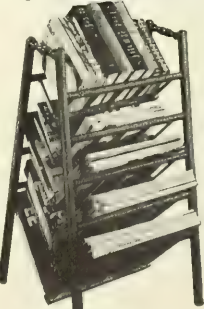

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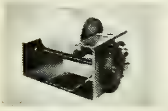

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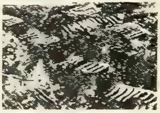

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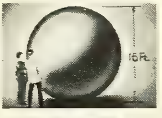

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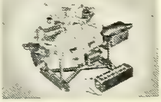

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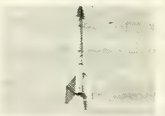

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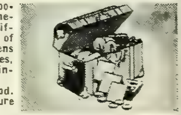

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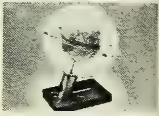

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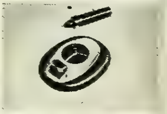

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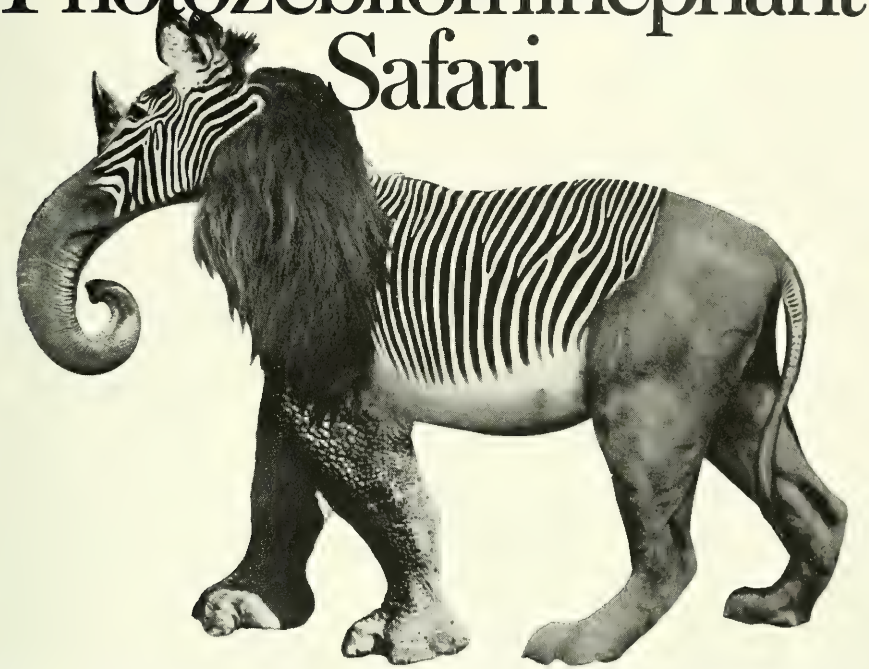

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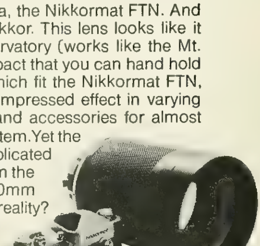

NATURAL HISTORY

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The interchangeable back.
It's just as important as the interchangeable lens.

In the beginning the camera was a one-piece unit.

Then somebody had an idea. If the lenses could be made to change, then the camera could be made to see more. And the interchangeable lens was born.

Victor Hasselblad had an equally interesting idea when he set out to build his 2¼″ single lens reflex. If the back could be made to change, he reasoned, then you could build other backs for other purposes.

Then if you could also change the viewer, and the film advance mechanism, and then could add on all kinds of accessories, you'd have much more than a camera. You'd have a whole system of photography. And the Hasselblad System was born.

Today, many good cameras have interchangeable lenses. Some have interchangeable viewers. But few have interchangeable film magazines.

Which is puzzling. Because a fixed back really ties a camera down, by letting it do only one thing at a time.

For example, with other cameras you have to finish or waste your roll of black and white before you can change to color. With Hasselblad you can switch from black and white to color, or from color negative to color reversal film at any time, simply by switching backs. Each back is like having an extra camera.

And while other cameras can take only one size of film (such as 35mm), Hasselblad can take 120, 220 and 70mm film, as well as any of the numerous cut films. It's all done with interchangeable backs.

And where other cameras take film in a limited number of shots per roll, there are Hasselblad backs that give you 12, 16, 24 and even 70 exposures per roll.

Other cameras take pictures in one size only. Hasselblad gives you three choices of picture size, 2¼″x2¼″, 1⅝″x2¼″, 1⅝″x1⅝″ (for making superslides). It's all done with the same camera. Only the backs change.

With other cameras re-loading is time consuming. Which can cost you a lot of good shots. With Hasselblad you can carry a few extra pre-loaded backs and just snap them on as needed, for uninterrupted shooting. That's how the astronauts re-loaded their Hasselblads in space and on the moon.

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NATURAL HISTORY

VOL. LXXIX, No. 5 INCORPORATING NATURE MAGAZINE MAY 1970

THE JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

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Fidel Castro's Cuba combines recreation with a multiple-use philosophy in managing nationalized beach front and mountain parklands.

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COVER: *This covered jar figure, a unique find from central Mexico, shows Teotihuacán influence and probably dates to A.D. 400–500. The incised patterns across the eyes, representing a serpent, left, and a butterfly, right, are generally associated with water.*

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Publication Office: The American Museum of Natural History, Central Park West at 79th Street, New York, N.Y. 10024. Published monthly, October through May; bimonthly June to September, Subscription: $7.00 a year. In Canada and all other countries: $7.50 a year. Single copies $1.00. Second-class postage paid at New York, N.Y., and at additional offices.

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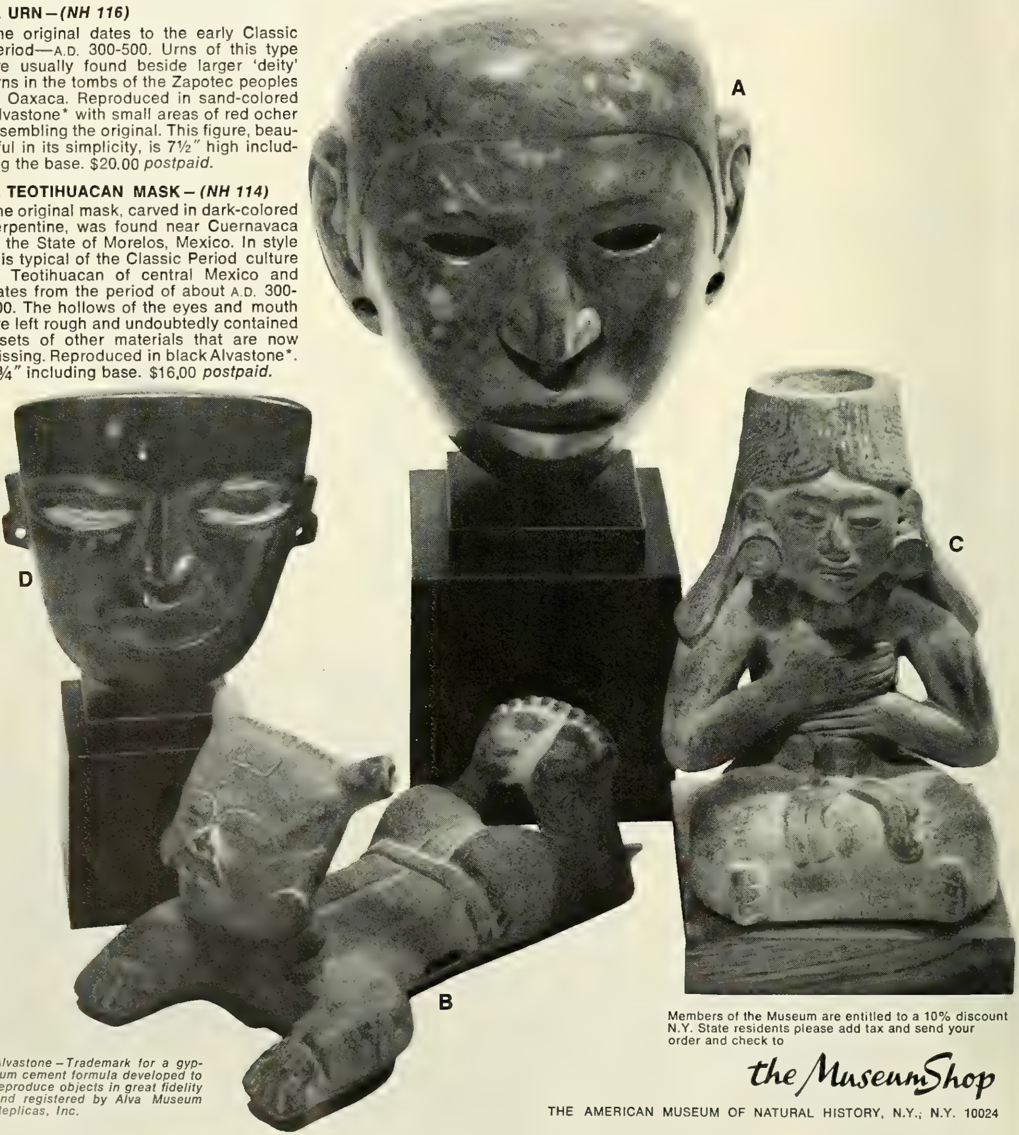
B. WHISTLE FIGURINE—*(NH 115)*
This amusing figurine of a child is of the Las Remojades Culture of central Vera Cruz. The face of the figure shows similarities to the famous Smiling Heads, which are the best-known of Las Remojadas sculptures. These appear to have been popular in the Late Classic Period, about A.D. 600-1000, and this is the approximate date we can give to this figure. It is 7" long and is reproduced in sand-colored Alvastone*. $18.50 *postpaid.*

C. URN—*(NH 116)*
The original dates to the early Classic Period—A.D. 300-500. Urns of this type are usually found beside larger 'deity' urns in the tombs of the Zapotec peoples of Oaxaca. Reproduced in sand-colored Alvastone* with small areas of red ocher resembling the original. This figure, beautiful in its simplicity, is 7½" high including the base. $20.00 *postpaid.*

D. TEOTIHUACAN MASK—*(NH 114)*
The original mask, carved in dark-colored serpentine, was found near Cuernavaca in the State of Morelos, Mexico. In style it is typical of the Classic Period culture of Teotihuacan of central Mexico and dates from the period of about A.D. 300-700. The hollows of the eyes and mouth are left rough and undoubtedly contained insets of other materials that are now missing. Reproduced in black Alvastone*. 6¾" including base. $16.00 *postpaid.*



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Authors

Everett Gendler obtained his B.A. from the University of Chicago in 1948, and then went on to study at the Jewish Theological Seminary. After being ordained as a rabbi in 1957, he did graduate work in history and philosophy of religions at Columbia University and Union Theological Seminary. Currently affiliated with Packard Manse, an ecumenical center in Stoughton, Massachusetts, and Hazurat Shalom Community Seminary in Somerville, Massachusetts, Rabbi Gendler spent three months in Havana during 1968-69 where he conceived the idea for an article on Cuban national parks. The author of several articles and essays, he is particularly interested in the redefinition of contemporary religious thought.

A free-lance writer living in Kalamazoo, Michigan, **John Eastman** is the author of "Biology of the Way-Out." As our "Naturalist at Large" this month, Mr. Eastman discusses the problem of abnormal behavior in animal species, particularly birds, and its importance, through publication in scientific journals, as an area of biological investigation. Since receiving his B.S. degree in biology from Michigan State University in 1965, he has worked as a biological assistant for the Illinois Natural History Survey and as a manuscript editor of biological textbooks. His previous work for NATURAL HISTORY includes "A Field Guide to Field Guides," November, 1969.

Lee Boltin was staff photographer for several years at The American Museum of Natural History. As a free-lance photographer, he has done assignments for NATURAL HISTORY and other leading national magazines. Best known for his photographs of sculpture, he recently completed a catalog for The American Museum in connection with the opening this month of the Museum's Ancient Mexico and Central America Hall.

Assistant professor of biological science at Florida State University since 1967, **William F. Herrnkind** has conducted intensive research on the spiny lobster during the last several years. His work in this area involves mechanisms of navigation and mass migration. He has also studied orientation mechanisms in crustaceans and shore and reef ecology in Florida and the Bahamas. The author of several scientific articles, Dr. Herrnkind received his M.S. and Ph.D. degrees from the University of Miami.

C.D. Darlington, the author of "The Origins of Agriculture," has been Sherardian Professor of Botany at Oxford University, keeper of the Botanic Gardens, and fellow of Magdalen College since 1953. For fifteen years previously he was director of the John Innes Horticultural Institution. He became a fellow of the Royal Society in 1941, was awarded its Royal Medal in 1946, and was president of the British Genetical Society from 1943 to 1946. Professor Darlington has written many well-known books on genetics, cytology, and evolution, the latest of which is *The Evolution of Man and Society,* to be published by Simon and Schuster later this year. He was also a founder of the journal *Heredity.*

The second part of "East is a Big Bird" by **Thomas Gladwin** examines the complex system of navigation devised by the Puluwatans. Coauthor of "Truk: Man in Paradise" and *Mental Subnormality: Biological, Psychological and Cultural Factors,* and the author of *Poverty U.S.A.* as well as many other works, Dr. Gladwin has done extensive field research in Truk (Micronesia, 1947) and Puluwat (1967).

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Letters to the Editor

Thermal Pollution

Richard B. Klein's "Bananas in Vermont" was interesting reading, but his treatment of the Atomic Energy Commission and what he calls lack of attention to imaginative solutions for the thermal pollution problem is hardly fair. He implies that if there were no nuclear plants in Vermont, there would be no thermal pollution problems. The difference in the polluting capacity of fossil plants and nuclear plants is not worth getting excited about if both stay within the restrictions already set by the Federal Water Pollution Control Administration. In any case, and unfortunately, the law does not give AEC or the Federal Power Commission authority to regulate hot water discharges from power plants. Nevertheless, the AEC is working hard on ways to reduce thermal pollution. The advent of higher temperature and thus more efficient reactor plants (High-Temperature Gas-Cooled Reactors, Liquid-Metal-Cooled Breeder and Molten-Salt Breeder), due to go onstream in the next decade, will provide thermal efficiencies at least as good as the best fossil burners. But all of us must accept the fact that thermal pollution of air or water is going to continue to be a problem as long as electricity is generated—whether from fossil fuel or nuclear fuel since it is an absolutely inescapable by-product.

We at the Oak Ridge National Laboratory have been working (for AEC and HUD) on ways to utilize heat and reduce heat discharge to streams for nearly two years. Our work has examined beneficial uses of waste heat, such as de-salting water, recycling sewage and waste water, heating and cooling cities, heating and cooling large food production facilities (greenhouses, poultry houses, fish culture ponds, etc.). Several of these applications appear attractive in special situations (such as Vermont's). They are all technically feasible—even banana culture—but they are not likely to provide much abatement unless implemented on a very large scale, because the quantities of heat are so large. Capital outlay requirements are great enough to be problems in organization, finance and operation. For example, the heat requirements of greenhouses at Burlington, Vermont, assuming 30°F. below zero air temperature, would be only about 2.5 Mw(th) per acre. The relatively small Vermont Yankee 514-Mw(e) station could heat a 400-acre range and could produce maybe 100 million pounds of vegetables each year—enough to supply every person in Vermont with 250 pounds per year. Such quantities would either present a great sales opportunity or be a horrible marketing problem, depending on your point of view.

So we must explore problems which may not be apparent at first glance: the needs of a particular area; reliability of service; load factors; the cost of delivering the heat at different temperatures; the economics of vegetable, poultry, and fish culture in controlled environments for hundreds of acres of food-growing operations. We are optimistic about the outcome and firmly believe that the heat can be used profitably, but we feel that these and other related problems need to be studied more thoroughly before we claim that we can solve the waste heat problem.

More generally, we are convinced that the central problem is to get the waste heat transferred to the atmosphere (where it is subsequently radiated to outer space) with the least perturbation to the biosphere. This criterion underlies the FWPCA water temperature guidelines and also our efforts in aquatic ecology, cooling towers, and the like.

Finally, your readers might be interested to know that the concern of an increasing number of scientists is the change in planetary heat balance apparently being brought about by the additions of CO_2 ("greenhouse heating effect") and particulate matter ("higher albedo cooling effect") into the atmosphere, in large measure from emissions of fossil-fueled power plants.

SAM E. BEALL, JR.
Director, Reactor Division
Oak Ridge National Laboratory

Do Cows Sleep or Not?

In "The Evolution of Sleep," February, 1970, it was stated that those "familiar with various farmyard species of domesticated ungulates cannot recall having seen one of them lying down with eyes closed, obviously asleep."

Our neighbor's ponies are seen lying down in their pasture, obviously asleep, our neighbor's pigs are lying down obviously asleep, our neighbor's riding horses are seen lying down obviously asleep, and our own cows seem to be lying down much of the time either when they are in the barn or in their small pasture area. They certainly would appear to be asleep as they are most difficult to arouse sometimes, and one especially does quite a bit of snoring.

Hoard's Dairyman magazine of Fort Atkinson, Wisconsin, recently published an article on whether cows slept. I forget exactly what the article concluded, but I thought it said that cows slept. At any rate, I would insist that our cows sleep. And several older people have stated that they never saw a horse lie down to sleep; but perhaps a workhorse was keyed to his master's footsteps and would rise before his master got there, either expecting to be fed or to be harnessed; but I see lots of horses lying down.

MRS. ROBERT HILDEBRANDT
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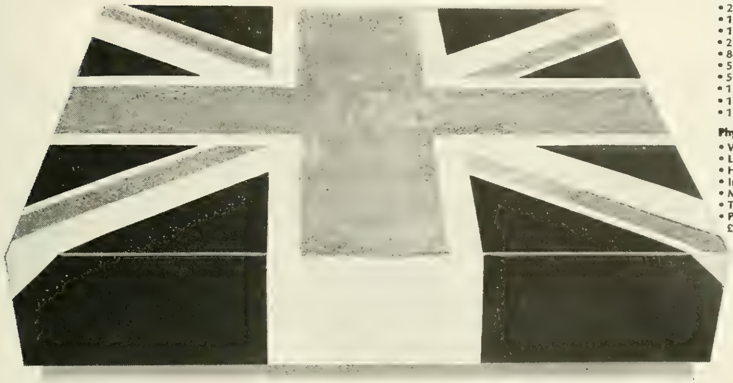

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- 2 "souvenirs" (Kitsch)
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Contributors

- John Lennon
- Yoko Ono
- Mario Amaya
- John Kosh
- Richard Smith
- Eduardo Paolozzi
- Michael Instone
- David Robinson
- J. H. Ballard
- John Tavener
- Christopher Logue
- Ian Hamilton Finley
- John Furnival
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- A "concrete" poem by Ian Hamilton Finley in the form of a two-page fold-out.
- John Lennon's LONDON DIARY. (Blue-nosed reviewers will have trouble with this one.)
- Two overripe Kitsch art "souvenirs" by Peter Blake.
- Eduardo Paolozzi's satiric 8-page GAY ATOMIC COLORING BOOK. Color it very Black.
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Where Have All the Beach Clubs of Ol

A glimpse of national parks in revolutionary Cuba

My immediate purpose in visiting Cuba recently was to minister to the religious needs of Havana's Jewish community, which had been without a rabbi for a number of years. But at the same time, I intended to learn as much as I could about a society that is experimenting radically in so many areas; and as a conservationist, I was especially curious about Cuba's policy and practice with regard to parks and recreation areas, such as beaches.

Cuba—whose population is now estimated to approach eight million—has more than 2,000 miles of coastline, and this includes some extraordinary beaches. The first excursion of my seven-week stay on the island was to the beach at Santa

avana Gone?

by Everett Gendler

María del Mar, which lies a half hour's drive east of Havana. (My transportation was provided by ICAP, the government agency that looks after foreign visitors to the island.) The golden sand of Santa María del Mar is some twenty yards wide, extends for more than a mile, and is bordered by a sizable planting of pine trees. I was struck not only by the physical beauty of the place but also by the public bus stops posted at frequent intervals along the road paralleling the beach and by the people emerging from the buses. I noticed, too, that the apartment and hotel facilities near the part of the beach I used did not impede access to it.

Although it was early October and, by Cuban standards, not prime

Monument to the island's aborigines, at left, stands in Zapata Peninsula National Park, not far from the Bay of Pigs.
Above, a postrevolutionary teachers' school in the wilderness of the Sierra Escambray National Park.

beach time, there was a sprinkling of people all along the water, among them a fair number of blacks. Talking with the bathers at random, I discovered that one couple, retired, were living rather modestly on their savings; another group comprised a working man and his family on off-season vacation: still another, workers off for the day. Unlike many beaches of the Caribbean, this was not the exclusive domain of the affluent and of tourists. It was quite clearly public property. Some 11,000 shower and locker facilities in the area were available for general use at hardly any cost.

The famous Varadero Beach, a

twelve-mile stretch of superb white sand about two hours west of Havana, exhibited some of the same characteristics. The International Hotel—a well-kept, prerevolutionary structure that represents the maximum of comfort presently available at Varadero—was at this off-season time mostly filled with tourists (East Germans and East Europeans, plus a few British, French, and Italians). On the beach, however, the egalitarian mood of Cuba today could be felt. I met a family of five from Oriente Province who were spending a week in a rented house not far from the hotel. Their house, which included a living room, terrace, kitchen, bathroom, and two bedrooms, cost about $80 (pesos) for the week; according to the family (the father was a mechanic), a vacation in a place like this is within the financial range of many Cuban working-class families.

How so? The island's minimum monthly wage is only $85. It is true that the basic necessities of life are inexpensive. Rent cannot exceed 10 percent of what the man of the house earns; medical care is free; education is free; and the children—300,000 of them at any rate—are given free school lunches. In addition more than half of the students receive full board, housing, and clothing. Rationed food is also comparatively inexpensive (eggs 4 centavos each, milk 20 centavos a liter, rice 5 centavos a pound). Still, how can a working-class family afford to spend something like a month's wages to rent a beach house for a week? The answer, my informant told me, is that, increasingly, all adult members of a family work—a growing number of day-care centers provide for the children while the mother is away—and so a family can draw on more than one salary. My informant assured me that vacations such as he was enjoying with his family were quite common.

Later when I asked the driver of my car about the vacation homes of Varadero and those who used them, he took me for a tour of several miles along the beach, where there were hundreds of homes like the one I had seen. He remarked at points along the way that they "used to be closed to us blacks." Poor people, he said, couldn't get near these beach areas. But now, he went on, "I can bring my wife here for a week, just like anybody else. So what do you think of our revolution?" Whatever else I may have thought about their revolution, I observed wherever I went in Cuba a use of the beach by local residents far exceeding anything I have seen on other Caribbean islands.

Once back in Havana, I went to the National Institute of Tourism (INIT) to find out more about the government's beach policies. I was told that major goals are preservation of the beauty of the beaches and assurance that they be maximally available to residents of Cuba; a secondary policy is to encourage the use of beaches by tourists to the island.

I learned that beach vacation homes owned by people who leave Cuba become state property. Owners of beach property who remain in Cuba are allowed to retain title to one beach home if they had owned it before the revolution. I did. in fact. meet two families who owned their beach houses as before. The state-owned beach houses are now available to families as vacation rental units, with stays limited to two weeks during the summer season of peak demand. There are also arrangements available for several families to share room and board. as well as facilities for single persons. All prices are fixed and reservations are controlled by INIT, which reports space for some 10,000 persons at Varadero alone.

Besides the residence facilities at Varadero, there are many additional units along the north coast between Santa María del Mar and Jibacoa. and the latter has extensive camping facilities directly on the beach.

The expanded day-use of beaches since the revolution is indicated by the newly constructed locker and shower facilities. refreshment and restaurant areas. and children's playgrounds. I saw these at Jibacoa, Siboney (Oriente Province), and in Havana. All are unobtrusively located near but not on the beach and the architecture struck me as handsome and spare. In Havana I also visited three formerly private beach clubs that are now open to the public.

Construction near the beaches has not been extensive; year-round housing and basic industrial development have first claim on the island's scarce construction resources. What will happen in the future? I was told that INIT has the authority, in consultation with the Central Planning Board (JUCEPLAN), to pass on construction projects near beaches. Depending, of course. on the taste and sensitivity of the planners. there is a chance that Cuba might be spared the unsightly, sprawling, and ultimately destructive "developments" that currently disfigure so many Caribbean beaches.

The rock-humped land of Vinales Valley in Pinar del Rio province is used by both farmers and hikers.

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Lester Davis is a friendly, dark-
ed little boy whose smile can light
an entire room. But for most of
s six years, he hasn't had much to
ile about.

Lester lives in Laurel Creek, an
palachian town of 200 people in
county with a per capita income
$557 a year. Like most of the
her people of Laurel Creek, Lester
es in a three-room weatherboard
use, along with his mother and
ther and nine brothers and sisters.
ey have no well, and of course no
ide plumbing. So Lester's mother,
essie, carries all the family water
from the nearby creek.

Lester's father, Ray, used to work
the coal mines, but since the
nes "played out" he's been unem-
oyed. As Tressie admits, "It's aw-
hard going. We never could get
a good start before." They still
uldn't have a "start" if it weren't
the Cossum family.

Ed and Martha Cossum live in
suburban community of contem-
rary homes. Looking out back you
n see one of those large, above-

ground plastic swimming pools. And you can see the beginnings of a redwood deck around the pool, which Ed and his two children, Bill and Carol, are
ilding themselves.

Ed is a systems analyst. He
ends most of his day thinking
out third generation computers.
rtunately, Ed and Martha also
nk about this generation of chil-
en living in Appalachia.

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ther can borrow to begin a self-
lp project.

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GRAN SIEMBRA DE PRIMAVERA

The Big Board: spring planting is charted for a greenbelt of citrus trees, sugar cane, bean and coffee plants near Havana.

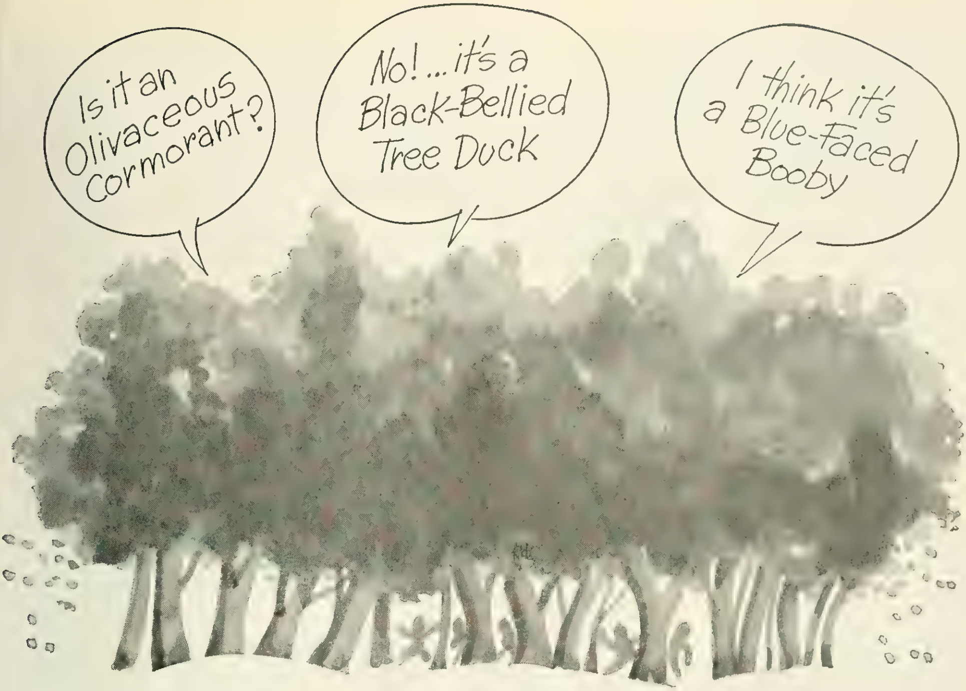
One other thing I saw on Cuba's coast—a sobering sight—should be mentioned. At several places between Havana and Matanzas there were oil derricks. Fortunately, they were not situated near the good beach areas nor were they located offshore (no Santa Barbara yet). They do, however, represent prospecting for petroleum deposits near the shoreline.

Since the economic blockade imposed by the United States, Cuba has been importing nearly all her oil from the Soviet bloc. Of the almost five million tons of fuel oil consumed in Cuba in a recent year, only 113,000 tons were produced domestically. Given the Cuban effort to mechanize agriculture and develop some industry, fuel consumption is likely to continue to rise and the search for local petroleum deposits will continue. One only hopes that no significant deposits lie near Santa María del Mar or Varadero.

The areas of Cuba officially designated as national parks are, for the most part, in mountain terrain, some of it difficult to reach. According to the most recent (1968) official map of Cuba, there are seven parks in all: four in Oriente Province, one in Las Villas, and two in Pinar del Río Province. In some respects the parks are much like our own—beautiful, largely untouched terrain, with perhaps some small areas devoted to recreational facilities or simple accommodations. There are, however, differences.

Two of the Cuban national parks, the Sierra Maestra and the Sierra Escambray, include within their boundaries teacher-training institutes of impressive size. The one I visited, Topes de Collantes in the Sierra Escambray park, was formerly a private sanitorium. Since the revolution, it has been enlarged and more than 7,000 students are now in residence, plus another thousand or so teachers, administrators, and construction workers. Although not what one would expect to find in a national park, the development has not obliterated a sense of the natural surroundings, whose ruggedness is felt throughout the institute.

Why a teacher-training institute in a national park? A member of the central committee of the Communist party—the central governing body of Cuba today—explained that they wish to encourage an appreciation of rural and mountainous settings, and thus develop teachers ready and eager to serve outside the cities. He gave other reasons, too, reasons that explain why at least two new towns have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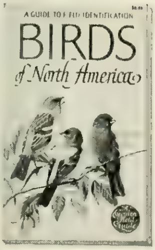
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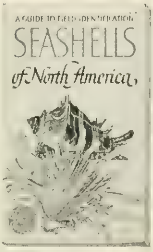
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been placed on the periphery of national parks.

In Oriente Province. the Sierra Cristal National Park has at its edge, in addition to a historical site (the Frank País Second Front Command Headquarters of the recent revolutionary struggle), the new town of Mayarí Arriba. Here a nucleus of some 7,000 inhabitants serves as a center for some 30,000 other people who reside in the surrounding area. Mayarí Arriba is complete with new housing units, shops, schools, medical facilities, a Círculo Infantil (day-care center for children under five years old), a public auditorium, a playground with rides, and a movie theater. The town represents part of the government's attempt to redress rural-urban imbalance by creating attractive living conditions outside cities (and by building teacher-training institutes there).

The other new, park-bordering town I visited is San Andrés, situated on the boundary of Los Organos National Park in Pinar del Río Province. As with Mayarí Arriba, there is a concerted effort to bring urban attractions to an underpopulated region.

How will these attractions affect the natural beauty of the parks? The member of the central committee to whom I addressed this question responded as follows: the new towns are at the edges of parks, not within them. The towns are carefully planned not to disfigure the natural surroundings; buildings are low, the environs remain for the most part untouched. Areas of the parks that were badly exploited in prerevolutionary times are benefiting from the government's massive reforestation program. (Nearly 330 million trees, not including citrus, were planted on the island between 1959 and 1965, and since then the rate of planting has increased four to five times.) In addition, he said, settlements at the borders of national parks means that they will enjoy greater human use. Finally, the roads that make a park area accessible cannot be limited to recreational use at this stage of Cuba's struggle to get beyond the state of underdevelopment. To be economical, a road must also serve resettlement and development.

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My reaction to these arguments was colored by the experience of overdevelopment and overaccessibility here in the United States. I often found myself trying to communicate these dangers to Cubans, but they saw such problems as a long way off: "Underdevelopment isn't overcome that quickly, compañero!" Meanwhile, they delight in a road that opens up an isolated area, for to them this represents a further improvement of the circumstances in which people live.

One of the most beautiful of Cuba's national parks is the one on Zapata Peninsula in a swamp area not far from Playa Girón (the Bay of Pigs). The Zapata Peninsula National Park, which includes turtle and crocodile hatcheries, is part of a major project in which canals were dredged and sided, windbreaks of pines were planted, and at the side of the Laguna del Tesoro (Treasure Lagoon), an entire vacation settlement, Guamá, was constructed. Guamá was built solely from local materials. For example, majagua was used for the exterior walls of the thatched-roof restaurant, mahogany for the floors, bamboo for the interior walls and a cir-

Pine plantings wall canals of the Zapata Peninsula park, formerly swampland.

cular staircase, wicker for lamps, and local pottery for dishes and ashtrays.

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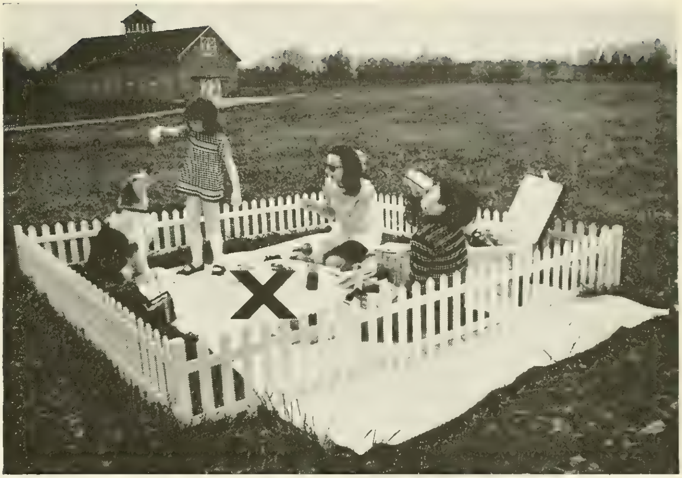
I was struck by one other feature of Guamá. To reach the cabins requires a 40-minute ride by motor launch from the entry point to the canals, and the dock itself is some miles inside the park. Hence Guamá is remarkably quiet: no automobiles anywhere and no traffic noise, not even from afar.

Cuba at this point appears to be treating her recreational facilities and park resources with some consideration. There is, moreover, a program of nature-oriented activi-



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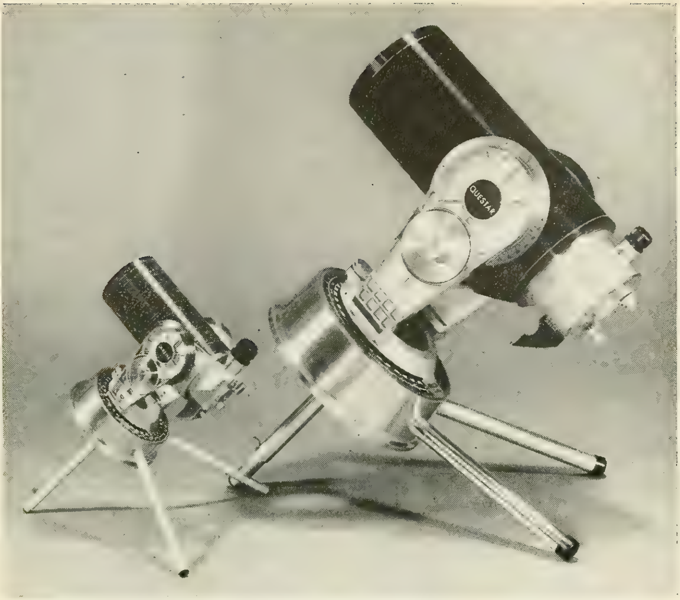
ties run by the Unión de Pioneros Cubanos, the Cuban Communist scouting movement, in which almost every school child participates. The Pioneros place heavy emphasis on matters of conservation.

Still I doubt that we shall ever see in Cuba a national-park policy with great stress on the preservation of wilderness as such, "Multiple use," to borrow from our own vocabulary, strikes me as the more likely tendency.

At first I was troubled by this. Yet on reflection it does seem that the stage of a country's development must be given weight in evaluating its conservation policies. Where resources are very limited; where immediate human needs are very pressing; and where, as in Cuba, much effort is being expended in reforestation, replanting, and repairing the ravages of former practices, multiple use may mean something different from what it usually means here.

But what will be the effect of Cuba's drive to develop industry and mechanize agriculture? To relieve men of physical exertion under a scorching Caribbean sun is understandable. indeed commendable. At the same time, coming from a society where labor-saving devices and so-called conveniences are increasingly assisting our alienation from nature while threatening to bury us alive with waste, I find myself wondering: Will the Cubans, too, fall prey to "progress" and "development"?

It seems to me that the question of parks and recreational facilities transcends political boundaries. All of us, whatever our nation or political system, must deplore the misuse anywhere of the natural resources entrusted to us for transmission to future generations. Equally, we can take heart from their wise, considerate use. I, for one, hope that conditions will soon permit a full and free exchange of observation and insight between Cubans and other citizens of the Western Hemisphere. Despite our different situations, such exchanges could contribute much to our mutual understanding. As fellow citizens of this planet, the use and abuse of parks and recreational facilities is a concern we all share. ■



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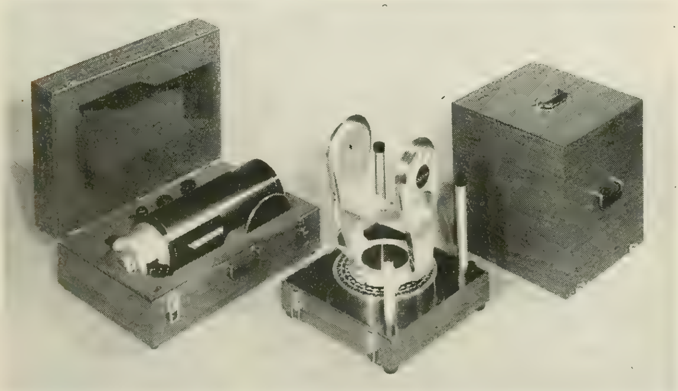

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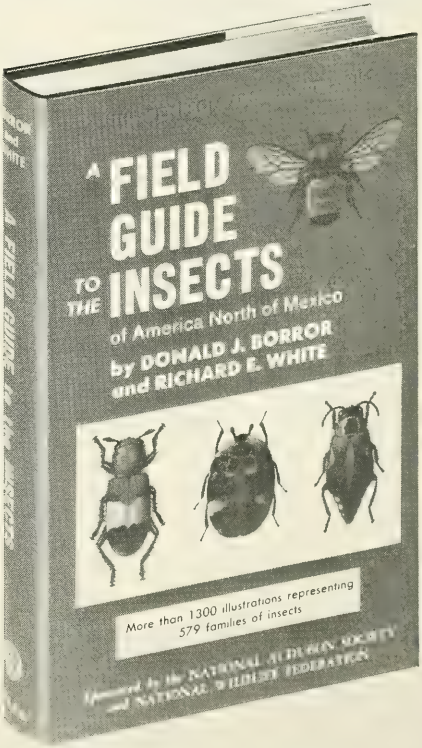
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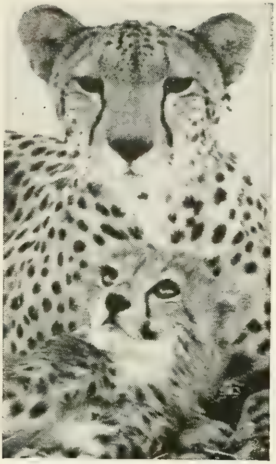

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A Naturalist at Large

Biology of the Way-Out

by John Eastman

Sometimes the lives of our animal brethren on this planet look like pretty settled business to us. Natural history is an establishment, and as such emphasizes history more than nature. Each known and studied species goes about achieving its reproduction, food, and shelter in precise and structured ways, according to what appear to be its own "laws" of instinct and survival. All we need do is to observe these behaviors and locate the creature's environmental slot; then we can define its adaptations and, with little fuss, write its biography. Occasional variations from the norm seem nowhere near as significant as the definitive pattern itself; so biologists often tend to rate the "abnormal" (when they don't ignore it entirely) as an inferior concern of serious study.

Still, those forms and behaviors most conveniently labeled abnormal deserve better of biology than they've received. Because this science, if any, is truly the study of becoming, of life always moving—to change, dead end, or blossom. Evolution occurs by abnormal adaptations, by way-out developments and strange pioneers. Certain ancestors of every living species appeared quite abnormal, no doubt, in the company of their normal, but now extinct, peers.

In man's realm, too, the tendency to limit life's expressions to the familiar is an old story. New inventions christened by horselaugh, new music hooted, new ideas banned and new heretics of every threatening persuasion lit, hatcheted, and shot. The fear of allowing anything new is plainly documented in our own natural history.

While recognizing these tendencies, we are nonetheless curious about the future. The only way we may be able to preview where many organisms are biologically headed is by taking a second look at these "outlaws"—just as we might anticipate what our grandchildren may consider stuffy and proper by observing what is bizarre about our children today.

Nowhere does truth blaze wilder than fiction than in the natural world. Exceptions to all sorts of rules abound in front of our eyes. Of course, the unusual things witnessed may not weigh equally in terms of plotting the long-range future of a species—few scientists would hazard predictions from one or two instances—but these deviations may tell us something about an organism's capacities, its possible ability to adapt. They can teach us respect for variation, and they can teach us to keep our eyes open, even in the most mundane and predictable circumstances of observation.

A good place to observe what many biological outlaws are doing is in the biological journals. Biologists who concentrate on a few, possibly only one, species are well trained to report their observations in precise, scientific terms. That's different from the neighbor down the block telling us about a "crazy robin" or a "tame squirrel." In almost every issue of the quarterly journals, scientists add to the outlaw records. The frequent appearance of oddities and curiosities in these journals is more often a byproduct than a result of serious research. It's simply a matter of conscientious habit to get them recorded in the literature. And the best part of it for those interested in strange animal tales, is that these reports can be trusted.

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These include *The Wilson Bulletin*, *The Auk*, *The Condor*, and *Bird-Banding*, among others. Various smaller journals, such as *The Jack-Pine Warbler* of my own state Audubon Society (Michigan), although always cramped budgetwise, have nevertheless achieved an esteem that far transcends their limited circulations. Some of the most conscientious researchers in the country publish in these small journals, receiving no payment; indeed, they usually pay for their own reprints, since the publications are, more often than not, precariously funded. But they maintain rigorous standards, and their additions to scientific literature are monuments to the loving care of scholarship.

In looking for reports of way-out things in some of these journals, I found an item about turkey vultures (*Cathartes aura*). Some creatures possess more power over human feelings than others, and the turkey vulture is a bird that claims this power. It demonstrates the capacity to arouse epithets like "disgusting habits," "foul," and "hideous," mostly from nature writers who lack any real respect for nature. While all of us may share some visceral feelings toward vultures, I don't know of anyone who isn't fascinated by them. Though vultures are members of the raptor tribe, most of them, unlike hawks and eagles, are scavengers, carrion eaters unable to kill prey. A great deal of keen observation (although not nearly enough) has been focused on these huge birds, and their necrophagous behavior has, no doubt, accounted for much of the interest. The facts seemed clear-cut until Helmut C. Mueller and Daniel D. Berger witnessed a turkey vulture killing and eating a house sparrow (*Passer domesticus*). Although the sparrow was tethered near a mist-net (restricting its motions), the basic significance of the observation, as reported in *The Auk*, was important. Turkey vultures *can*, if only in special circumstances, kill prey. That's something new, something to watch.

Vultures surprise us in other ways, too. In *Nature* (a British journal not restricted to ornithology), Jan and Hugo van Lawick-Goodall came up with a startling observation on Egyptian vul-

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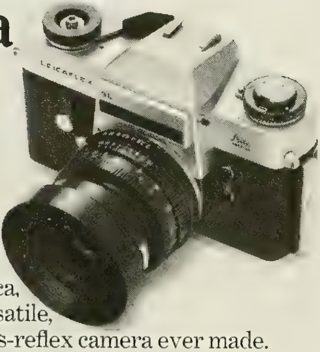

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tures (*Neophron percnopterus*). These birds, according to the two investigators, use stones as tools for opening ostrich eggs.

It may be that tool-using behavior by vertebrates other than man isn't as rare as zoologists once thought. Every year more species are added to this particular list. Among the latest is the brown-headed nuthatch (*Sitta pusilla*) as reported by Douglass H. Morse in *The Wilson Bulletin* of June, 1968. These small forest birds remove pine bark scales and use them as wedges in prying up other random bark scales; then forage upon the newly exposed surfaces for insects. Morse thinks that tool use among the birds he observed is a local characteristic only and not a trait of the species at large. But once again, we see adaptive capacities demonstrated, a specific finding that enlarges the picture and gives other observers chances to zero in and learn more.

Among outdoor professionals fire is a dirty word, and has been for a long time. It's easy to see why; but it's also plain that the peculiar anathema of fire owes much to propaganda preached over the years by foresters, who, after all, have no more money to burn than the rest of us. From the economic aspect, fire remains a dirty word indeed.

Ecologically, however, a whole new area of research involving fire is opening up. The findings are, in many cases, not as surprising as our massive scientific ignorance of the subject. American Indians knew the uses of fire on land, and at least one bird species, the Kirtland's warbler (*Dendroica kirtlandii*), has apparently evolved dependency upon a periodic conflagration for renewal of its jack-pine nesting habitat.

Now come rather direct hints that fire, far from wreaking absolute havoc in the environment, was a force integrated by the ecosystem millions of years before man came to witness and fear its capacity to destroy. To say that fire is not an unnatural, "outside force" is now considerably less heretical than it used to be. Pioneers like Herbert L. Stoddard and E. V. Komarek in Georgia have conclusively demonstrated the beneficial effects of prescribed burning, not only on game

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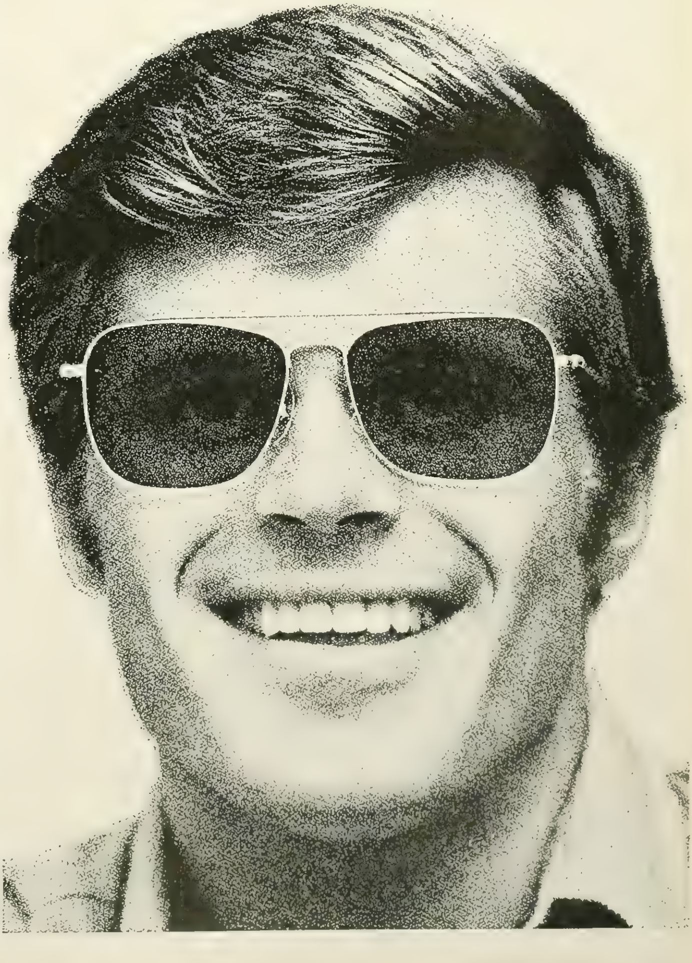

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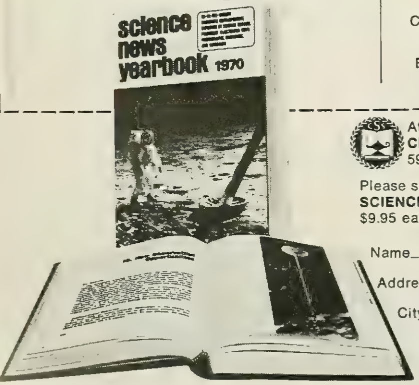

production but on timber as well. Fire ecology is slowly coming into its own, both as a habitat-management tool and as a rich field for basic, solid research. If previous theoretical experience furnishes any guidelines, we may probably expect to discover many more adaptations among animals to fire.

A recent note in *The Wilson Bulletin* encourages this expectation. The observation concerned the responses to fire of three Illinois game birds, and it interested me particularly because I had the brief good luck to work with the two investigators during the beginning phase of their controlled-burn experiments. William R. Edwards and Jack A. Ellis report that bobwhites (*Colinus virginianus*), mourning doves (*Zenaidura macroura*), and American woodcocks (*Philohela minor*) "responded positively" to fire in their environment. These actions took the form of calm, deliberate behavior by the birds; in most cases they landed and flew close to the flames without apparent alarm.

In contrast to most of the data, such observations make us wonder how much we really know about normal behavior. Despite our scare-oriented conditioning by Bambi and Smokey the Bear, we have much to learn about fire and its effects.

Probably no area of bird research has matched the attention that structural abnormalities receive in almost every issue of the journals. Deviations in wings, bills, feet, and coloration from the species norms are easily spotted—and lucky the observer who spots one, since, if the deformity isn't too common, it's usually good for a few lines in a reputable journal. Usually these brief notes consist of no more than a detailed description of the abnormality and the circumstances of observation, but their inclusion in scientific journals furnishes a useful, credible record.

After many years of this kind of cataloguing, ornithologists are now learning that such structural abnormalities aren't that rare in bird populations. Joseph J. Hickey, in his classic *Guide to Bird Watching,* charts the results of a 1934 banding program in which 10,000 starlings were trapped and examined. More than 5 percent of the birds possessed deformities, ranging from clubfeet and swallowtails to hooked bills and partial albinism. Many deformities result from accidents, of course, and the means birds develop to compensate for missing legs, broken bills, and injured wings make notable reading in the journals. But genetic defects may, as we know, provide new directions for the operation of natural selection on the species as a whole—so that 5 percent of starlings could represent the most important part of the starling population in terms of the long-range health of the species (not that we need any more starlings). And that's why the strange, the deformed, and the different continue to merit space in the journals. Such news keeps us alert to what can happen, and what can happen, may.

Nevertheless, a reaction is growing against the profusion of reported abnormalities flooding the scientific journals. In a recent issue of *The Wilson Bulletin*, Kenneth C. Parkes of the Carnegie Museum in Pittsburgh suggests that the occurrence of crossed bills in birds is so common that observers ought to stop taking up valuable space in the journals reporting it. Parkes isn't likely to win any popularity contests among his peers for that shot. That he can now make such a suggestion validates the usefulness of the data, of course, as well as the space that the data have filled in the journals. The luxury of clear conclusion is hard-won through the efforts of many; but it is the goal of all scientific observation.

A big attraction of the journals is that whatever the biological future holds, prophetic hints of it are likely to show up in their pages first. Think what a story we could relate if biologists had been around to record the abnormalities among the Eocene avifauna. Maybe our own far descendants (providing we leave them any world at all) will be able to indulge in some really luxurious conclusions.

The annual index for
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(January through December 1969)
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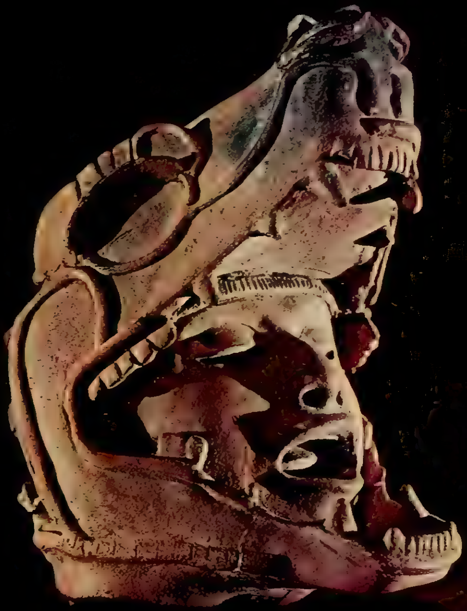
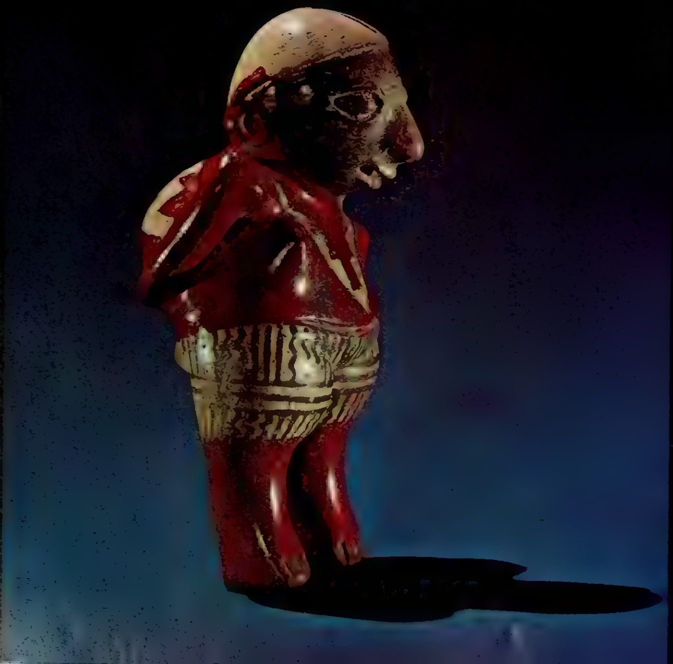
ANCIENT MEXICO AND CENTRAL AMERICA

Photographs by Lee Boltin

Maya ceramic figure from Campeche, Mexico. (11 inches)



Human head in mouth of jaguar, ceramic fragment. Vera Cruz, Mexico. (9 inches)

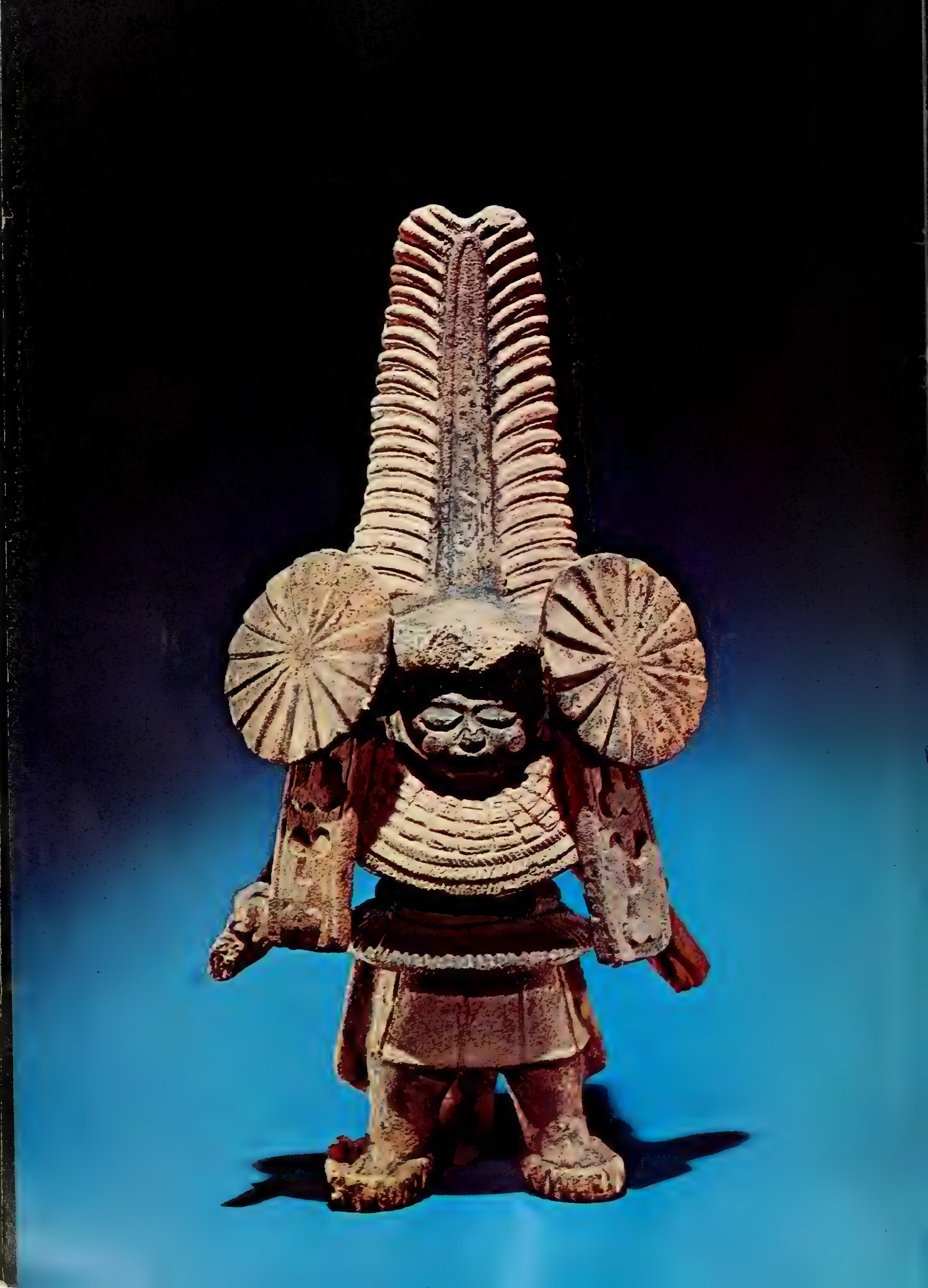


Hunchback ceramic figure. Western Mexico. ($6\frac{1}{4}$ inches)

Three views of he
of ceramic figu
Nayarit, Western Mexic
($28\frac{1}{2}$ inches over-al

Before the voyages of Columbus and Cortez made it known to Europeans in the early part of the sixteenth century, the area of Mexico and Central America was occupied by various peoples — Mayas, Aztecs, Zapotecs, Totonacs, and many others. Each of these groups was linguistically and culturally distinct, but they all were part of and together formed a larger unit, which we now identify as the civilization of Middle America, or Mesoamerica.

We think of Middle American civilization as something equivalent to the several early civilizations of the Old World:



Ceramic figure with tall headdress, Vera Cruz, Mexico. (8 inches)

Ancient Egypt, the Near East, or Bronze Age China. Like them, Middle America was characterized by large, permanently settled populations living amid impressive productions of art and architecture, by cities and advanced political systems, by complex religious and ceremonial organization, and by thriving markets and wide-ranging commerce.

By 1890, when anthropology as a scientific discipline was little more than a generation old, the scope of The American Museum's Department of Anthropology was broadened to include archeology. Its field research comprised pioneer studies in the reconstruction of Middle American history. It began much of the detailed work of filling in the picture of Mexico's and Central America's cultures, their sequence and their geographic distribution. This month the Museum's new Hall of Mexico and Central America opens to the public. The photographs shown here, from the 128-page book based on the Hall, are just a token of the Museum's collection, but they open the way to an appreciation of the great artistic and creative spirit that animated Middle American civilization.

MIGRATION OF THE

During autumnal mass movements, thousands of lobsters march along the sea bottom in strikingly straight queues of up to fifty animals each

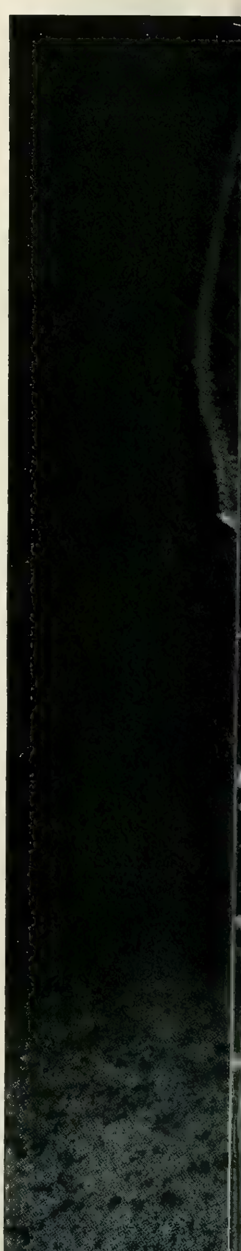
by William F. Herrnkind

The migrations and mass movements of animals have long influenced man and stirred his curiosity. He has wondered about the cause and purpose of the periodic exodus by lemmings and the incredible navigational capabilities of salmon returning to their home stream or adult eels returning to spawn at their birthplace a thousand miles out in the Sargasso Sea. I, too, have been intrigued by the appearance overhead of hundreds of Canada geese in V-formations and by the swirling masses of wormlike black elvers in the estuaries near my childhood home. However, while I had occasionally reflected on these phenomena, it was not until 1963 that I began to direct my scientific research toward comprehending such events, particularly one that is, curiously, both spectacular and virtually unknown.

As a graduate student assistant working on a bioacoustic research program at the Institute of Marine and Atmospheric Science, University of Miami, it was my job one October day to trace a breakdown in the underwater cable linking our hydrophones to The American Museum's Lerner Marine Laboratory in Bimini. The installation was located on the edge of the Florida Strait at a depth of 65 feet. Sea conditions, which had been intolerable owing to an autumnal squall, had improved enough to permit my co-worker and me to maneuver out in a skiff to the vicinity of a main junction in the cable. We donned SCUBA gear and dropped into the murky water to begin a search for the splice box. Particulate matter, stirred up and held in suspension by the rough seas, limited underwater visibility to 15 feet in an area where it is usually about 100 feet. Peering through the haze below me as I sank, I saw what I first believed to be long, dark furrows or waterlogged timbers lying on the bottom, but as I dropped farther they resolved into lines of dozens of spiny lobsters, *Panulirus argus*, marching head to tail in single-file.

I was surprised because this delectable creature is typified by its sparse numbers in the open sand areas where we located our acoustic array. As I settled onto the bottom, still another column marched steadily by without missing a step. I realized then that I was witnessing a "crawl," or "crawfish walk," long known to professional fishermen and other old salts, but poorly known and, in some cases, disbelieved by marine scientists. I first heard of these mass movements of thousands of lobsters from biologist William C. Cummings, who had witnessed a similar event off Bimini in 1961. I also realized, as another column of twenty lobsters went by, that we would be unable to locate the splice box in such murky water, so we spent as much time as possible studying the lobsters.

These mass, single-file marches by spiny lobsters are unique, the only known formation movements by bottom-living crustaceans. Furthermore, the marches markedly contradict the established view of this species' behavior pattern. Spiny lobsters are nocturnally ac-



A distant, clawless relative of our Maine lobster, the spiny lobster lives mainly in the Caribbean and in the waters of the Bahamas.

SPINY LOBSTER

tive; they wander about at night to feed on annelid worms and small mollusks, but return before daybreak to shelter in crevices on the reef, under rock ledges, or among dense fronds of sea whips. Why, then, do all the lobsters in a region become active each fall, moving by day, in formation, over exposed areas where they are never seen at other times?

Perhaps the most striking feature of the mass movements, aside from the sheer numbers involved, is the single-file formation, which I call a queue. Some other crustaceans travel in more or less definable groups: fiddler crabs and soldier crabs form great droves, or herds, which scour the beach for food at low tide, while some shrimps aggregate in clusters, or schools. However, none approach a stable, spatial configuration to match the long, straight queues of *Panulirus argus*. All queuing lobsters maintain the precise course and speed of the leader and move through turns as though they were on rails. More amazing is that all the queues, no matter how far apart, travel in equivalent or parallel headings! Just how do the lobsters organize themselves into queues, establish leadership, and maintain formation? What is the biological significance of the mass migrations? Where do the migrants come from and where are they going? The questions seem endless.

The difficulty of answering them lies in the necessity of performing much of the research in the sea at a relatively unpredictable time, at a relatively unpredictable location, under conditions that severely restrict visual studies. In studying the Arctic tern or indigo bunting, at least we know where they come from, where they go, and what they do when they get there (although we still don't know *how* they navigate). After observing that marching horde of spiny lobsters, I felt irresistibly challenged to discover their secrets.

At first my lobster research proceeded slowly since I was committed to a doctoral research problem on a distant relative of the spiny lobster, the fiddler crab. This doctoral research provided useful background when I later tackled the more formidable problem of lobster migration and orientation.

Other sources of help were the numerous professional lobstermen, conservation officers, and skin divers I spoke with, who related their observations of similar marches in different regions. In all cases the general descriptions were similar—the events took place in the fall after intense storms and involved large numbers of lobsters of approximately the same size, traveling in long queues. Each queue in a given march headed in the same compass bearing, and the compass bearing was specific to each location. The stories told to me also suggested striking behavior I had never witnessed myself. For example, a fisheries officer from Florida described a marching column that extended, with few breaks in rank, for nearly one-quarter mile: that would conservatively comprise one thousand spiny lobsters. Several Biminites independently told of an immense number of lobsters that wandered into the Bimini Lagoon and, upon reaching a cul de sac along the shore, swirled about in a great mass with many individuals walking out of the water onto the beach. During 1969 in Bimini a migration occurred in which about ten lobstermen captured an estimated 20,000 lobsters in five days. And they by no means caught them all, probably less than 10 percent.

A colorful description of a march by one Bimini fisherman included the explanation that the lobsters migrate when they get "the spirit." I have subsequently found that this is a valid descriptive term for the internal state of the animals during these events. For my first opportunity to observe the persistence of this spirit I must thank a fellow student at Miami who called me at one o'clock one morning to invite me to witness a mass movement at Boca Raton. I gathered my diving paraphernalia and drove up in the wee hours to get overboard at daybreak. Sure enough, the columns of lobsters were marching alongshore and were literally piling up at a rock jetty, which looked from underwater like a pincushion of antennae. I mainly wanted some undamaged live specimens to bring back to the Marine Institute for study, but had overlooked bringing my

Constant contact enables all queue members to walk at the same speed and in the same direction, even when the leader detours around an obstruction.

hand nets. A feverish chase ensued, during which I captured some live specimens and hauled them back to a vinyl-lined seawater pool, 15 feet in diameter. Upon release, a group formed a queue and marched clockwise around the pool almost continuously, day and night, for the next two weeks. All in all, it was almost five weeks, and an estimated 500 miles, before the marching activity halted along the endless migratory pathway presented by the perimeter of the circular pool.

During that time I fed the lobsters and attempted to induce them to enter a concrete block shelter. However, they would eat only for brief periods interspersed with marching and would not take up residence in the shelters. This matches the behavior exhibited by lobsters while marching in the sea. There, certain members of a file stop occasionally and grasp such objects as starfish and small sea cucumbers, then move on, eating as they march. Columns also cluster under rock ledges for some minutes, as many as 200 in a 10 cubic foot space, with groups continually forming and moving off as others arrive. All these actions are in strong contrast to the responses of both captive and wild lobsters at other times, when feeding lasts much longer and the shelters are inhabited through the daylight hours.

The extraordinary behavior of captive migrating lobsters under artificial conditions suggests that their "spirit" is a modified internal state, or drive, responsible for the maintenance of the migratory activity. It might be likened to the internal processes that cause birds to become restless at the time of migration, a condition termed Zugunruhe. In some birds Zugunruhe is brought on by a modification of the hormonal system, the result of changes in day length or, more simply, photoperiod. Thus, as fall days shorten and nights lengthen in the North Temperate Zone, changes in birds' internal processes are manifested as a general increase in activity and a tendency to fly southward. A similar Zugunruhe occurs in the spring increase of photoperiod, but brings on a tendency to fly northward. The seasonal nature of the mass movements by spiny lobsters, and the continuous hyperactivity of captive specimens, suggests control by some internal process brought on previously by environmental changes associated with autumn.

The autumnal storms always reported to precede the marches seemed a strong possibility at first as a cause of the internal changes. But present evidence suggests that this is not so. Violent storms also occur at other times of year—particularly in the winter, spring, and in association with summer hurricanes and tropical depressions—but marches have been reported only during the September through November period. And, in the area off Bimini where I had made my original observation, a small march of brief duration occurred in October, 1969, during a two-week period of almost uninterrupted calm.

It appears, then, that some other factor brings on the internal state preparatory to migration, and that storms at that time act to trigger and synchronize the movement of the population.

This past summer I investigated some nutritive factors as possible causes. This was suggested by marine biologist Robert Schroeder, who mentioned that captive lobsters would begin to march around their enclosure shortly after being switched from a mollusk diet to fish, as though fish lacked some necessary substance that inhibited the Zugunruhe or, perhaps, contained some inductive substance lacking in mollusks. To test this effect I placed groups of ten lobsters in three pools provided with running seawater, sand substrate, and terra-cotta pipes for refuge. Except for the dietary regime, each group had nearly identical conditions. We fed the mollusk group surf clams, the fish group chopped fish, and the third group nothing, and monitored the activity patterns daily for any changes. By the fourth day the fish group became hyperactive and exhibited marching during the day, while the others retained the normal pattern of inactivity by day, thus confirming Schroeder's observations. The situation remained the same through the following week indicating a relatively long-lasting effect.

At this time we switched the diets of the fish group and mollusk group. Activity decreased daily in the new mollusk group (former fish group) and increased in the new fish group (former mollusk group). Thus, a change in diet is a factor that can control activity and is a

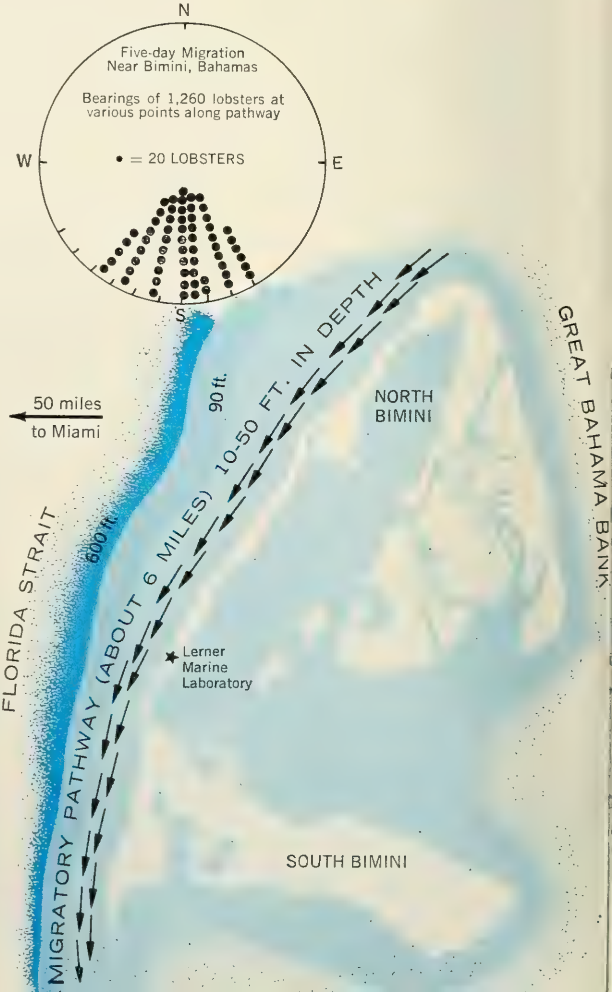
possible cause of migration. However, the animals given no food behaved in accord with the normal nocturnal pattern, leaving us in a quandary. If the lack of some substance in fish causes the migratory state, why doesn't the absence of food have the same effect? It may be that fish flesh contains an induction substance, but we feel that this would be a remote possibility as a cause of mass movements in nature since spiny lobsters probably do not ever eat fish; they simply are not equipped to catch them.

Fish-fed lobsters, however, may continually add body tissues lacking in some necessary substance(s) found in mollusks, which must be kept in balance with the added body material for normal growth. The imbalance causes modifications in the metabolic system that subsequently result in the migratory state. Starved lobsters gain none of this substance either, but they are losing, not adding body material and, therefore, are not affected in the same way. More studies of the type described, along with studies of internal processes, must be conducted to define the role of nutrition as a causal factor.

Other factors may also work independently of, or in conjunction with, dietary modifications to bring on the migrations. For example, photoperiod seems a likely possibility: light exerts a strong influence on the hormonal physiology and behavior of many crustaceans, including *Panulirus argus*. And temperature flux may be involved, since temperature drops of several degrees centigrade often result from autumn storm activities. Another possibility is increase in population density, which most of you may have already thought of in connection with lemming and locust emigrations. Being gregarious, lobsters tend to cluster by day in habitable crevices, so an increase in immigrants or an increase in the living biomass of lobsters in the population, as occurs during synchronous molting, might produce a density effect culminating in emigration from that area.

We do not yet have conclusive evidence about where the lobsters come from or go. At present, I believe that migrant lobsters off Bimini originate in shallow areas well to the north of the island group. Finding their ultimate destination is a problem in tracking. Using a sonic pinger tag, which pulses a signal detectable by directional hydrophone, I was able to follow a lobster at Bimini by boat for several miles. The path of this specimen, and others I've observed in the area, suggests that the migrants disperse into suitable habitats along the west edge of the Bahama Bank five to ten miles south of Bimini. An expanded tracking program should clarify this in the future.

When we turn to the striking feature of queuing, we find that it is a basic component of this species' behavioral repertoire, since even young lobsters two to three inches



During November, 1969, migration, lobsters maintained strong southerly bearing, despite turbulent seas. Beginning and end of pathway are unknown.

long sometimes form single-file lines. Queues also occur at times other than the mass movements—whenever a group of lobsters is deprived of shelter or is introduced to a novel habitat situation. This tendency to congregate—even in the large circular pools of the laboratory—has enabled me to observe the sequence of queue formation and the sensory mechanisms used in maintaining it.

I recorded data on queuing by means of an event recorder. This device has separate, manual push-buttons for each of twenty pens, which trace paths on a moving chart. Thus a button coded for each separate action was depressed by the observer whenever that action took place and for as long as it lasted. Afterward, the chart was reviewed to determine the number of times an action occurred, its duration, and its sequential relationship.

We found that an isolated, stationary lobster visually perceives, and directs its antennae toward, a moving individual up to several yards away. It then queues up by approaching the moving lobster from behind until antennal contact is made. At this point its antennules are brought into contact with each side of the lead lobster's abdomen, completing the alignment. The queue is maintained by the almost constant contact of the antennules or by the hooking of the tips of the pereiopods (walking legs) around the telson (tail) of the lead lobster. This tactile locking into place enables all the queue members to walk at the same speed and in the same direction, resulting in strikingly straight columns of up to 50 lobsters. The contact also permits the queue to maintain its integrity when the leader changes course to detour an obstruction. The significance of constant contact is suggested by the effort that separated individuals immediately make to close up any gaps.

But could lobsters deprived of their antennae, antennules, or anteriormost pereiopods still queue? Losses of these appendages are common in nature. To test this, we recorded and compared the performance of individuals deprived of one of these receptor-appendages either by forcing autotomy (self-release of appendages at certain joints) or by taping them up so they could not receive stimulation. In all three cases the lobsters could still queue since they substituted usage of one of the other remaining appendages. The lobsters, like the Apollo moonships, possess redundant back-up systems to take the place of any one that should fail.

The strongest evidence for concluding that tactile cues are the most important for aligning and maintaining the queue formation came from studies on lobsters blinded by opaque tape. These would queue up only after some tactile contact was made with another lobster, at which time the taped lobster turned neatly into alignment and maintained position as effectively as untaped individuals. It seems likely, then, that spiny lobsters can queue even in cloudy water and at night.

Since the queue involves a number of lobsters led by only one individual, it would seem that the leader should be outstanding for some noticeable attribute—perhaps size, indicative of age and experience, or peculiar behavior recognizable by the others. However, upon examination of over fifty "leaders" captured during one migration, we found them to fall by size and sex ratio right in the average for all the lobsters collected at that time. This, together with our laboratory studies, suggests that leadership is produced, not by exterior appearance, but by the behavioral manifestation of some inner drive.

Queues that I observed in the open sea formed in several ways, but the following was the most striking: Lobsters clustered together in a closely packed group and turned about the center in a tight circle, giving the impression of rotation. At some point an individual moved off tangentially, pursued by the other lobsters. The formation then became a queue as individuals fell into single file.

In the indoor pools, queues

The author takes notes underwater while releasing specimens during orientation experiments off North Bimini.

formed in back of those individuals that were most actively moving about the enclosure. Tests with "models" made from molted lobster carapaces mounted on glass rods proved that activity is the most crucial sign stimulus for leadership. I was able to induce queuing by merely moving the model about the test pool near the captive lobsters, in some cases even when they were inactive.

The question of the significance of queuing to survival arises. Answering this is far more difficult than determining the mechanism of queuing because it implies that the behavior has selective value in maintaining the species. As an educated guess, lobster queuing probably performs a defensive function. These lobsters are not offensive creatures of prey; they possess no claws or other weapons of attack. They rely on defense for their survival: hiding in a hard, horny armor, which deters all but the largest or hardest-mouthed fishes; moving rapidly when in retreat, as the telson snaps forward propelling them backward; and keeping the abdomen, the least-protected portion of their anatomy, under a rock ledge. The pointed, hard front end is exposed to the predator, which usually gets either puncture wounds or a meal consisting of a spiny, almost hollow, autotomized antenna for its trouble. In open areas away from rock ledges, the abdomens of queuing lobsters are "protected" by the cephalothorax of the lobster behind. Of course, the last individual in line is at a decided disadvantage. Hiding under a rock doesn't always work either. My research assistant once came upon a lobster that had retreated from the open to the safety of a rock crevice only to find itself grasped tightly by a large *Octopus vulgaris* already in residence there.

The ability to move in a straight queue, whether or not the formation offers protection, seems of little value unless the movement is directed somewhere. This aspect of orientation brings up exciting problems because spiny lobsters are capable of feats that defy explanation. Witnesses of mass movements reported that all lobsters in a given area traveled in about the same direction although the direction varied from area to area: southerly at Bimini, northerly at Boca Raton, westerly at Grand Bahama. During the fall of 1969, at the Lerner Marine Laboratory in Bimini I observed a five-day mass movement and recorded the bearings of over 250 queues comprising some 2,000 spiny lobsters. The headings were strongly to the south over a distance of at least six miles. The lobsters maintained that bearing while moving over substrate of variable slope and at varying depths, in water visibility less than six feet, under completely overcast skies, and in areas of complex currents, all of which either occlude guidance cues or make them extremely variable. To appreciate this, consider yourself trying to walk on a direct course several miles through hill country, without a compass, in a dense London-style fog, while being buffeted by strong winds from different angles.

The most astounding performance by spiny lobsters occurred in experiments in Bermuda in 1949. Edwin Creaser and Dorothy Travis trapped and tagged lobsters, then released them at various distant locations. Afterward they regularly checked lobster traps located at the points of capture for any returns. Two lobsters released out at sea at a depth of 1,500 feet, two miles from the original point of capture, were retaken less than one week later! Since lobsters sink rapidly and are benthic creatures, it is unlikely they swam back near the surface. Returning two miles along the sea floor in virtually complete darkness suggests either a very effective guidance mechanism or a whole lot of luck.

To test orientational capabilities, I captured lobsters in nonmigratory condition from selected areas in the waters off Bimini. The animals were marked and released underwater at depths of 15 to 30 feet on level submarine sand plains devoid of vegetation. Each lobster's path was recorded on a plastic slate until it passed out of sight. The animal was then retrieved and released again to a total of eight times, each time at a compass heading 45 degrees from the preceding one to control for any bias introduced by the direction the lobster was facing at the time of release.

The typical behavior of 26 lobsters after 208 releases was forward locomotion for a few yards, followed by a turn to a new heading, then direct movement over the underwater horizon. Twenty of the 26 lobsters distributed their runs in a nonuniform manner, that is, all eight runs fell in a specific range of compass bearings (within the 90 degree sector from west to north). Several individuals followed parallel paths on each release, crossing within 10 degrees or a few yards of a given point on three or four runs. We interpret this behavior as an indication of their ability to orient themselves and maintain a bearing in a relatively featureless area.

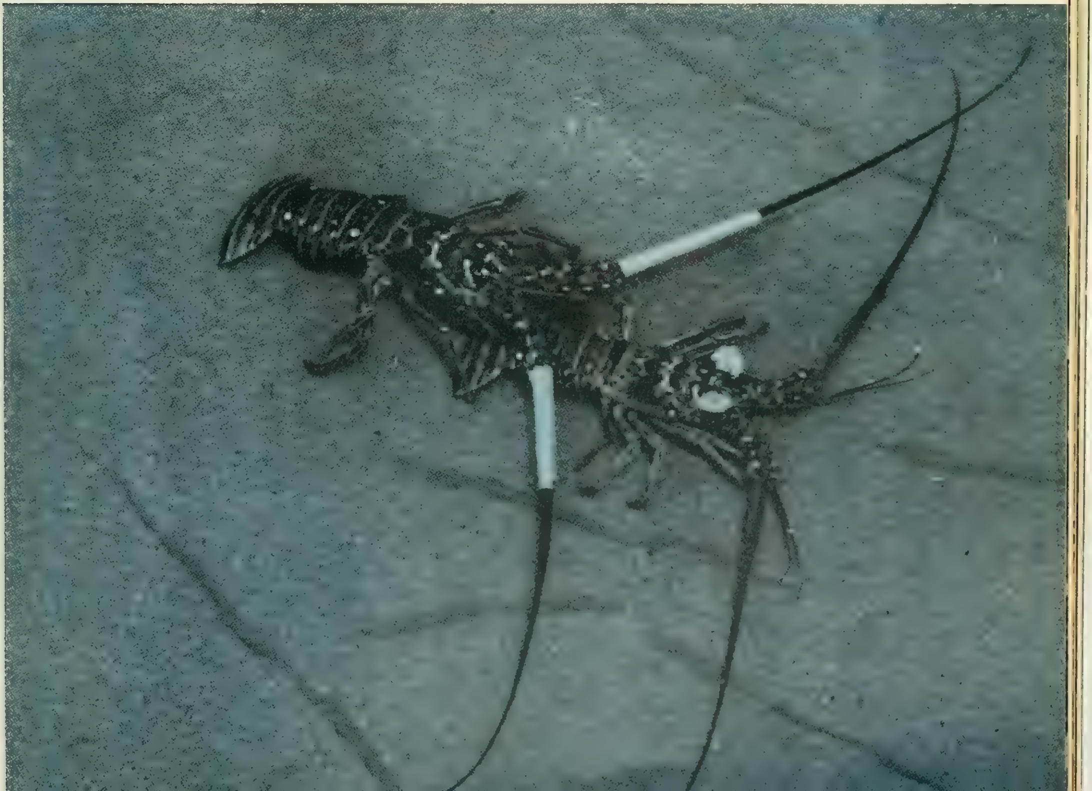
Convinced that spiny lobsters were capable of establishing a course in the open sea, we next wondered whether the process was effected visually. In further orientation experiments using lobsters blinded by opaque tape, twelve of fourteen lobsters exhibited parallel headings on each of the eight runs. In fact, several showed stronger orientation than the unblinded lobsters. It was particularly startling to release to the south a lobster that had previously run north and have it immediately turn 180 degrees and walk across my plastic slate. Doubtless, the spiny lobster can establish bearings without vision, which is not too surprising since they are nocturnal animals. But we are left with the question of what sensory mechanism and what environmental guidance cues are used to accomplish orientation under nonvisual conditions.

At this point we are not presuming that a single cue or mechanism is the only possible guidance factor. Rather we are alert to having several physical stimuli operating to guide the migration under different conditions. We feel this way for two reasons. First, it is becoming more and more apparent that other orienting animals, such as salmon, bees, pigeons, and fiddler crabs, respond to several types of cues. For instance, fiddlers can and do orient their movements by the sun and polarized sky when underwater, in tall grass, and under other conditions when only the sky is visible. However, if they are on the open beach, they orient by local landmarks even when the sun is clearly visible. So, if landmarks aren't available they use the sun-compass, if the sun isn't visible they use landmarks, and if neither is visible, as during rain or fog, we have some evidence that they don't bother to move more than a few yards away from the sanctuary of their burrows. The environment of the spiny lobster also has cues such as the sun, landmarks, and bottom slope available under some conditions, and these cannot be eliminated as possibilities.

A second reason is evident if one looks closely at the sensory capabilities of spiny lobsters. They have large eyes capable, at least, of recognizing other spiny lobsters; fine chemical and tactile sensors in each antennule, pereiopod tip, and also around the mouth: as well as tactile sensors in the telson and antennae. Internally there are proprioceptors, which sense not only movements of the appendages but also external forces such as gravity and uneven pressures. Additionally, there are indications of numerous receptors we have not yet characterized. If you look at the scanning electromicrographs taken of surface features, you will see numerous hairlike processes, clumps of setae, and pits in the chitin.

The functions of some of these are not yet known and one gets the strong impression that the spiny lobster is equipped as a walking undersea probe. Between the multitudinous physical cues of the ocean and the equally varied receptors, a self-contained guidance unit may be operating, exceeding any that man has yet devised.

When key sensory receptors are taped during experiments, lobsters still queue; they simply substitute other appendages to lock into place.



Sky Reporter

And Now Collapsars As the proprietors of a discipline that often manages to be the newest as well as the oldest of the sciences, astronomers frequently find themselves coining names for new phenomena. Recently, followers of the science have been introduced to quasars (quasi-stellar objects) and pulsars (pulsing radio sources). Now they have to contend with "collapsars."

The term refers to a star that has collapsed into extremely dense, compact matter; its gravitational field becomes so strong that no light can escape its surface. Such an object disappears from the visible universe. For this reason collapsars can never be directly observed, a characteristic that at first thought would seem to make theoretical discussions about them an exercise in futility. But according to most current cosmological theories, the total amount of matter in galaxies in the form of stars and clouds of gas and dust is substantially less than what calculations show it should be. Invisible collapsars could account for the missing mass.

Sea-floor Spreading on the Moon Continental drift and sea-floor spreading, the scientific bandwagon of the 1960's, are now being invoked for the moon as well as the earth. The idea is to explain the lunar seas, the *maria*, as areas of the moon where hot material from the interior broke through the surface, pushing back the older upland areas and creating broad expanses of relatively smooth terrain.

J. W. Elder, a geophysicist at Cambridge University in England, proposed this lunar application in the journal *Nature*. In making his case, he offered analogies with the earth, for which the drift theory is now generally accepted, as well as the results of his work with a laboratory model in which blobs of a hot, viscous fluid well up to a cooled surface, pushing aside continental crust represented by a thin layer of aluminum powder.

Elder cites the fact that lunar domes occur almost exclusively in the *maria* and argues that they may be analogous to the volcanic cones on terrestrial ocean floors. This type of volcanism does not occur on continental areas, he points out. Then he notes that the rills, ridges, and other structures found on the *maria* can be identified with similar ridge systems on the ocean floors of the earth and with results produced in his laboratory model; he considers them evidence of activity beneath the surface. He also points to lunar mountain chains that often border the *maria* and compares them to the island chains formed at the edge of terrestrial seas where a spreading sea floor pushes up against a continental margin.

According to Elder's thesis, all planet-sized bodies go through the same surface-roiling process as they cool after formation. In a small body such as the moon, cooling is rapid and convection currents in its upper layers quickly lose strength; the surface of the body "freezes" into its final shape. On a larger body such as the earth, sufficient energy is left at this point for weaker secondary processes to continue. Blobs may no longer have the energy to penetrate the surface, but the slow turning over of material beneath the surface carries the continents along as though they were on conveyor belts.

How to Make a Spiral Galaxy To an observer with a life-span of 10 billion years or so, the spiral galaxies that dot the universe may appear to be so many pyrotechnic pinwheels, throwing off gobs of glowing material, which in turn eject still more galaxy-sized sparks.

This spectacular picture could offer the best explanation of how such galaxies (including ours) acquire spiral arms and why, as a galaxy rotates with its center moving faster than the outer reaches, the arms do not simply wind up and disappear. The proposal comes from Halton Arp of the Mount Wilson and Palomar Observatories, writing in the European journal *Astronomy and Astrophysics*.

The prototype spiral galaxy is the Whirlpool Nebula in the constellation Canes Venatici; amateur astronomers know it as number 51 in the Messier catalog of deep-sky objects. Its spiral arms were first detected in 1845, decades before astronomers realized the galaxies were, in fact, island universes far distant from our own.

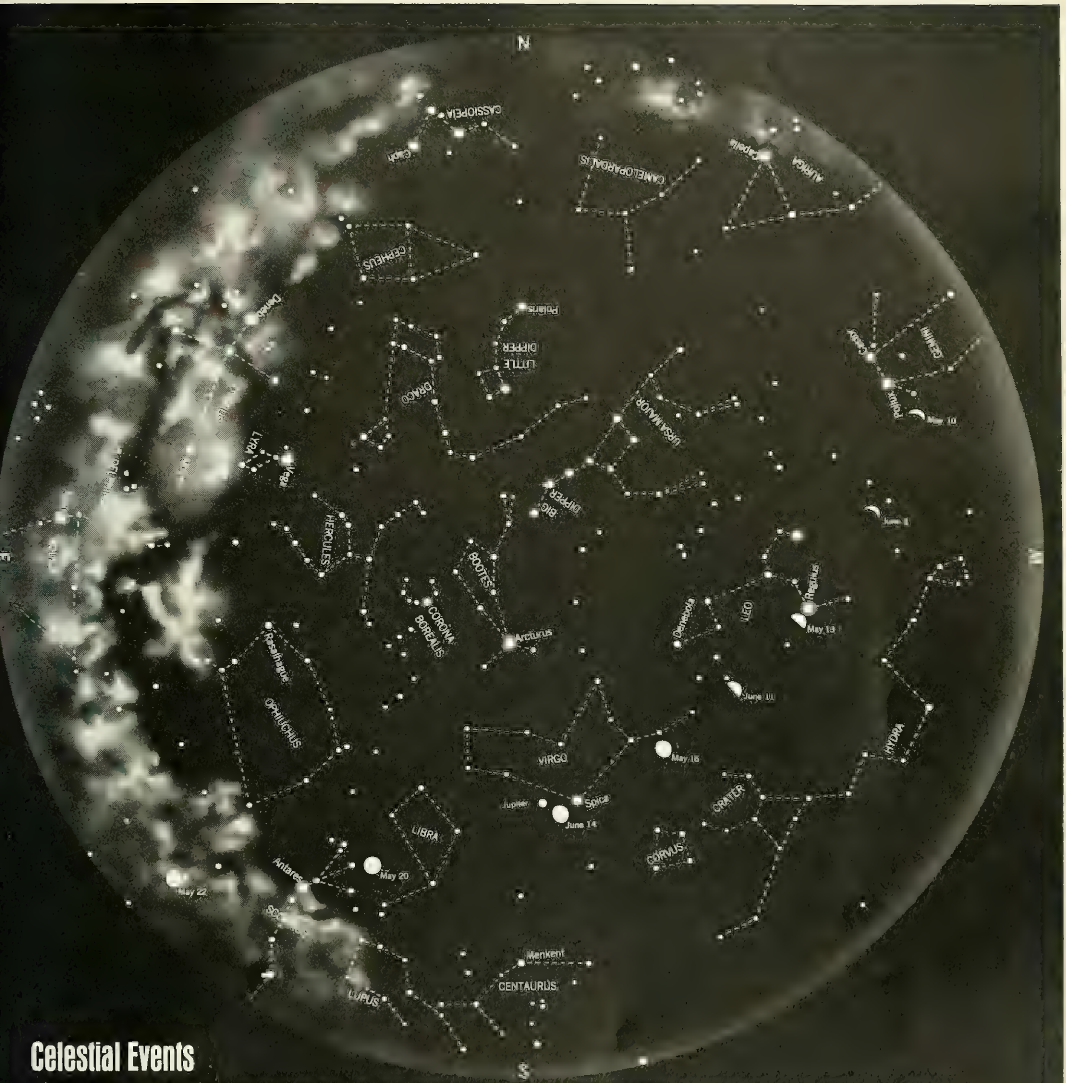
Arp focused his study on spirals that have companion galaxies at the end of one or more spiral arms; he considers these companions to be masses of material ejected from the nucleus of their parent galaxy 10 to 100 million years ago. Presumably they were smaller than their parent nuclei when first ejected, but they have now expanded to comparable size. The companions are galaxies in their own right, complete with stars, gas, and dust; they act like galaxies in going on to eject material of their own.

There are well-known cases in which a galaxy is ejecting material in the form of a jet or as a discrete object. Radio astronomers have known for years that many galaxies are flanked by pairs of radio sources, apparently ejected in opposite directions. Even in the case of our own galaxy, there is some evidence that a bridge of hydrogen extends from the galaxy to two small companions, the Magellanic Clouds. A secondary ejection appears to be going on in the smaller cloud.

Arp believes that the spiral arms form when masses of material are ejected on opposite sides of a galaxy, but readily admits that in many cases there is a visible companion at the end of only one of two spiral arms. He suggests that in these cases the second ejected body may have moved beyond the end of the arm, may have expanded to the point where it is too dissipated to be seen, or may not yet have expanded to visible size.

Arp believes that the spiral arms do wind up as the galaxy rotates, but that by the time they do, the bright, supergiant stars that mark them have faded. The arms dissolve into the general galactic disk. While this is happening, however, new ejections are forming new arms. Thus the galactic disk builds up even as more and more arms are formed.

John P. Wiley, Jr.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CASSIOPEIA
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CEPHEUS
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LITTLE DIPPER
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Castor
Pollux
May 10
URSA MAJOR
LYRA
Vega
BIG DIPPER
June 8
HERCULES
BOOTES
CORONA BOREALIS
Regulus
LEO
Denebola
May 13
Arcturus
Rasalhague
OPHIUCHUS
June 11
HYDRA
VIRGO
May 16
Jupiter
Spica
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CRATER
LIBRA
CORVUS
Antares
May 20
May 22
SCORPIUS
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CENTAURUS
LUPUS
S

Celestial Events

The moon in May is new on the 5th, at first-quarter on the 13th, full on the 20th, and at last-quarter on the 27th. There will be a new moon on June 3, and a first-quarter moon on June 11.

In the evening sky, Venus (the brighter) and Mars are low in the west, separating slowly. Jupiter is high in the southeast at dusk, and it sets before sunrise. Saturn and Mercury pass from the evening to the morning sky.

May 9: Transit of Mercury, partly visible after sunrise in eastern and central United States. Venus and Mars are in conjunction.

May 13: Occultation of Regulus by the moon, partly visible in eastern United States as Regulus emerges about 8:20 P.M., EST.

May 17: Mercury and Saturn are in conjunction.

May 18: Jupiter is near the moon this evening.

May 21: Mercury resumes direct (eastward) motion

May 28: Mercury and Saturn are again in conjunction.

June 2: Saturn is near the rising crescent moon this morning.

June 4: Mercury is at greatest elongation in the morning sky. It may be seen low in the east after dawn.

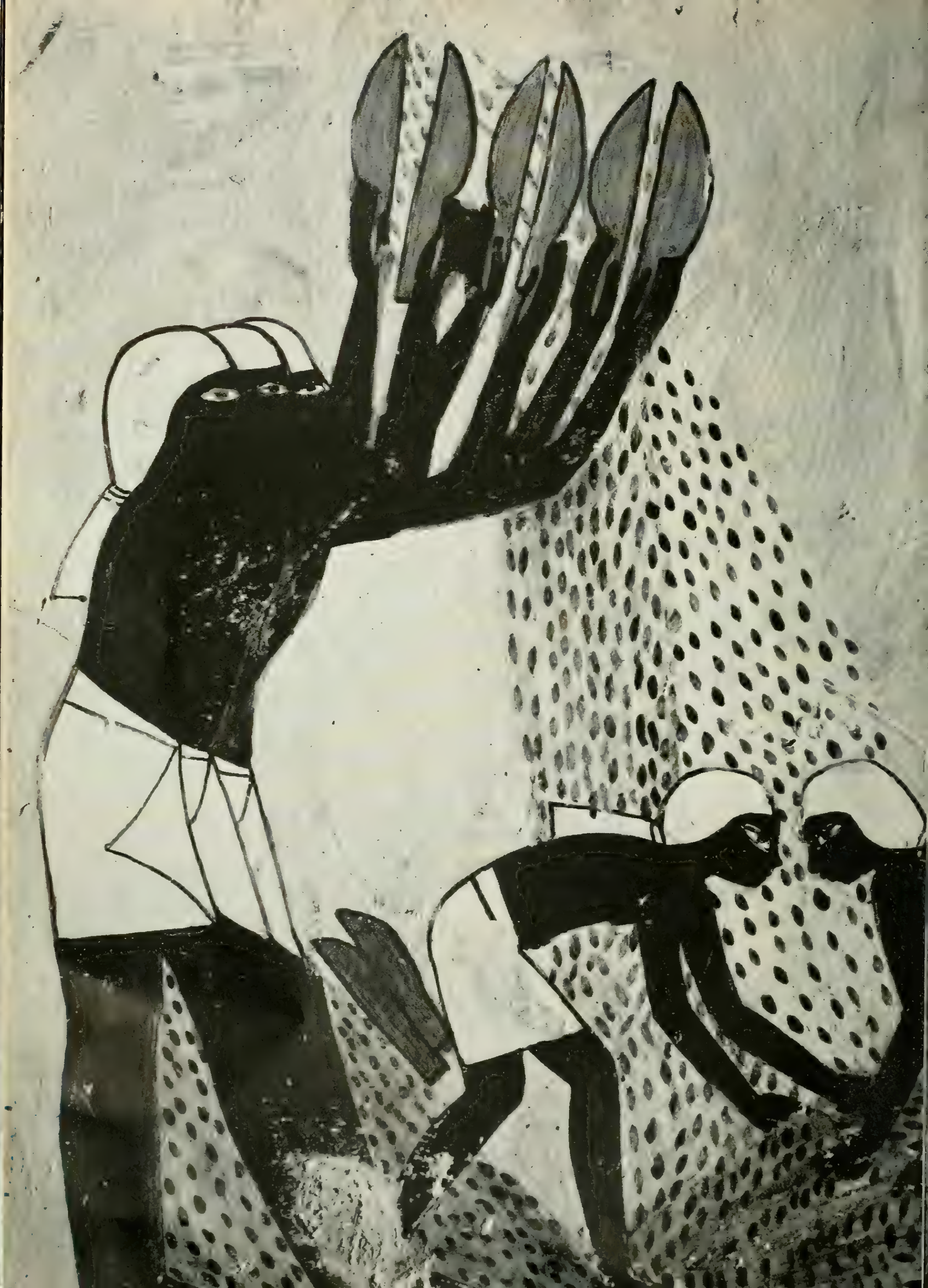
June 5: Venus and Mars are on either side of the crescent moon.

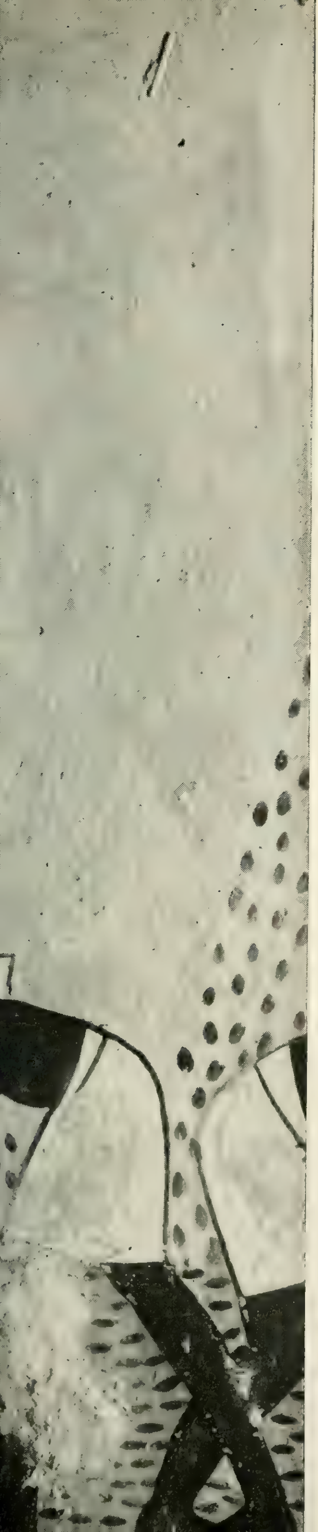
June 11-12: Venus is near the stars Pollux and Castor, in Gemini.

June 14: Jupiter is near the gibbous moon tonight.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky. The map is for 11:25 P.M. on May 1; 10:30 P.M. on May 15; 9:25 P.M. on May 31; and 8:25 P.M. on June 15; but it may be used for about one hour before and after those times.





THE ORIGINS OF AGRICULTURE

The earliest grain farmers began to cultivate the wild ancestors of our crop plants about 10,000 years ago. Their unforeseen harvest was the transformation of human life

by C. D. Darlington

According to the notions of our forebears, early man first learned to forge and smelt iron to make his weapons and his tools. Then he tamed his beasts and tilled the earth, sowed the seeds of the plants he had collected for food, and so raised his crops. Finally, years of cultivation improved these crops to a standard that came to support agriculture. Man could now provide better fodder for his stock, and could, therefore, breed improved beasts. These developments had occurred in many parts of the world with different kinds of crops and stock on which the different civilizations were based.

This view of agriculture's origins had been reasonably supported by the European discovery of the American civilizations, and it was still generally held at the beginning of the nineteenth century. It showed man progressing almost inevitably by his own efforts, his own skill and intelligence, and in a way that commended itself well to the thought of the nineteenth century.

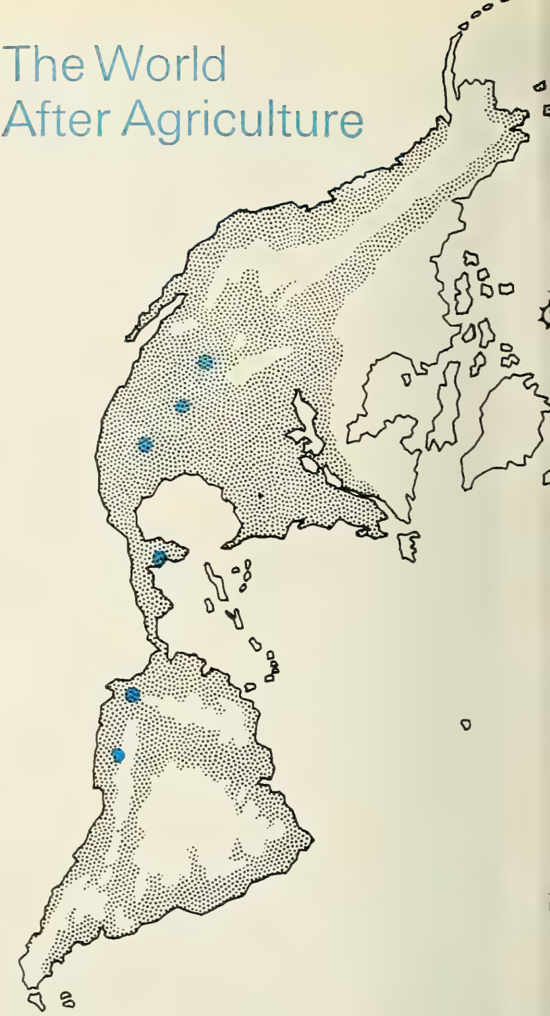
But in the middle of that century all these ideas were rudely shaken by a series of unforeseen discoveries. It was then that archeology began to show that agriculture had long preceded the smelting of metals. History and language began to indicate that crops had been carried far away from the places where they were first grown. And two naturalists, Darwin and De Candolle, argued that it was not cultivation in itself, but selection by the cultivator—the choice of species and the choice of variations to sow and propagate—that had played the decisive part in improving cultivated plants.

Darwin and De Candolle thus advanced our understanding of the origins of agriculture for the first time in two thousand years. In the hundred years that have followed them, however, a far greater upheaval of ideas has occurred. It has been set off from two directions. One was the study of how plant breeding and selection actually work among primitive farmers. This we owe largely to the Russian geneticist and plant breeder Nikolai Vavilov. The other was Willard Libby's 1947 discovery of the use of radiocarbon. This led to the physical dating of prehistoric remains and settled the arguments of earlier centuries. What happened when these two fields of inquiry, so utterly remote from one another, came together?

To see how these great advances transformed the problem of the origins of agriculture, we have to look at the world as it was when agriculture began, the world of 10,000 years ago.

First, consider the people. There were about five million people in the world. They were divided into

The World After Agriculture



thousands of tribes, all living by various kinds of hunting or collecting, mostly by both. Like their surviving descendants, these people often had special skills for dealing with foods and fibers, drugs and poisons, weapons and boats. The tribes also included some individual artists and craftsmen, as well as men with special knowledge of trade, especially trade in minerals—tools and ornaments, for example, made from obsidian, amber, and precious stones. But, in general, these people had a vast and accurate knowledge of what they could do with the plants, the animals, and the earth on which they depended for their living.

There was, however, one factor in their surroundings on which the main masses of mankind could not depend. This was the climate, for the climate at that time was changing unusually fast. The last Ice Age was in full retreat. The snow was melting all around what is now the temperate Northern Hemisphere. Mountain ranges were becoming passable. The oceans were rising and cutting off islands. Inland seas were drying up. In short, vast new regions were being opened or closed to human habitation.

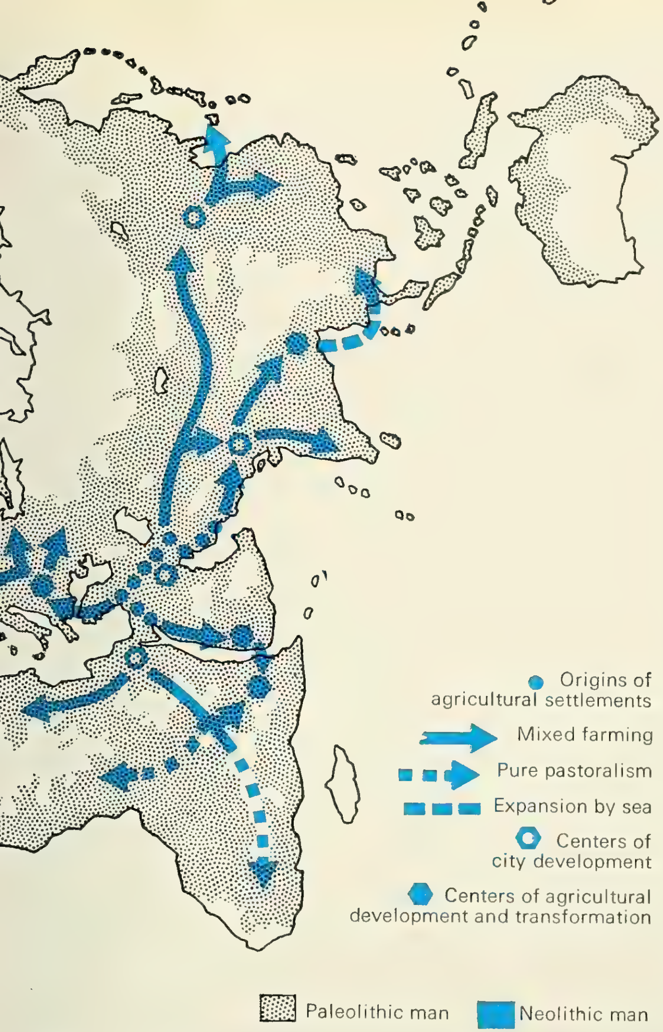
In these circumstances it is evident that movements of people must have been taking place on a greater scale than ever before. Inevitably the greatest movements of all, and the greatest meeting and mixing of peoples, would be concentrated in those necks of land that join the three continents of the Old World and the two continents of the New. Significantly, therefore, the first evidences of settled agriculture are found close to these necks of land.

Over the last twenty years, radiocarbon dating of the organic remains in a great number of early agricultural settlements has shown beyond doubt that agriculture began at different times in different regions. And it has shown the order in which it actually began in these different regions. The use of radiocarbon has corrected many slight —and a few big—misconceptions.

First, agriculture began, not exactly in what the American Egyptologist James Breasted called the Fertile Crescent, not in the fertile valley bottoms, but rather on the hillsides and tablelands adjoining them. This nuclear zone, as it has been called, is a three-pronged area stretching from the headwaters of the Euphrates, west through Anatolia into the Balkans, south into the Jordan Valley, and east along the foot of the Zagros Mountains toward the Persian Gulf. Later there was a fourth prong crossing Persia south of the Caspian Sea. In other words, the nuclear zone was just at the neck, or the crossroads, of the Old World.

Secondly, we find that this zone of original settlement did not expand—apart from seaside intrusions into Egypt and the Crimea—until about 4000 B.C. There are three or four silent millennia between the beginning of agriculture 10,000 years ago and the great transformation and expansion that followed it. To be sure, during this period pottery was invented. Artists and traders were attracted by the security of the permanent settlements and put their skills and goods at the service of the new, rich, settled communities. But the great technical and biological discoveries of bronze and writing, the wheel and the horse, lay ahead.

These discoveries were made only at the end of the silent millennia, when the great geographical


Origins of agricultural settlements
Mixed farming
Pure pastoralism
Expansion by sea
Centers of city development
Centers of agricultural development and transformation
Paleolithic man
Neolithic man

expansion was beginning. In the fourth millennium B.C. the tribes of grain cultivators began to move out of the nuclear zone and to settle or colonize the wild lands of the hunters and collectors, which lay around them. They moved in four main directions: into Europe, into Africa, into India, and into China. They had waited a long time to make these journeys, and they took a long time, more than a thousand years, to accomplish them. Why? The answer depends mainly on the crops they were cultivating. And, as we shall see, these crops give us the answers to several other questions.

That we know exactly what crops were cultivated by the earliest farmers is the result of the work of the Danish botanist Hans Helbaek. The foundation of their agriculture was wheat, and its two main forms continued to live and were cultivated side by side in the nuclear zone for the nine succeeding millennia. The first of these, known as emmer, existed and still exists there wild. The second does not exist wild. It is derived, as we know by experimental breeding and by looking at its chromosomes, from hybridization between emmer and a wild grass also still found growing in this region. This second grain is bread wheat, and today it is still the most important of all man's food crops.

Along with the two wheats, a variety of other food plants were cultivated, a variety that increased with the passing of time: peas and lentils for porridge, barley for beer, linseed for oil, and the vine for wine. Doubtless many unidentified fruits and vegetables were also collected, without at first being bred and cultivated.

But when men passed to the new lands the picture changed. In warmer Egypt linseed began to be grown, not for oil, but for fiber; it was retted and spun for flax and was used to make linen, the first substitute for wool. In colder Europe a new grain, oats, appeared beside the wheat. In India, cotton took the place of wool and flax. In Central Asia the native buckwheat displaced wheat and barley. On the Upper Nile, sorghum displaced the other grains. And almost everywhere various kinds of new light grains, the millets, began to take the place of the heavy-grained wheat and barley.

Some of these later displacements were no doubt due to conscious selection. But some, it seems, were quite unconscious. In 1916 a German geographer, Engelbrecht, attempted to account for these displacements. As a crop is taken into a new territory or habitat, it is apt to be invaded by new weeds. Rye appears as a weed of wheat and displaces the wheat as the crop moves north or moves higher into the mountains. This happens today with cultivated rye, and originally wild rye would have done the same.

No doubt this transformation of crops was exceedingly slow, and indeed its speed was probably the limiting factor in allowing the expansion of agriculture from the nuclear zone. The cultivator had to wait for an evolutionary change, which depended on processes of selection of which he was quite unconscious.

The idea of unconscious selection was Darwin's, but he had no idea how far it would go. It turns out to be the key to the understanding of the development of agriculture. The decisive changes undergone by cultivated plants are not, as one might suppose, in the visible yield, but in properties of behavior which, to the layman or nonfarmer, would seem unimportant.

The discovery of this principle was the main contribution of Vavilov, who found that nearly all cultivated plants had gone through certain parallel transformations. In cultivation they had lost the faculty of distributing their seeds, which was necessary for their survival in nature. And, at the same time, they had acquired a new faculty of submitting to convenient harvesting of fruits and threshing of seed, which was necessary for their survival in the hands of the cultivator.

Take the crowning instance of Vavilov's principle. The ear of wild emmer, when it is ripe, shatters into its separate parts, each containing one grain protected by its coat, the chaff, and armed with a beard that will catch in the coat of any passing animal. When the grain falls to the ground it will dig itself in. But the ear of cultivated emmer or bread wheat does not shatter when ripe. It can be cut and carried unbroken. Only when it is threshed does it gently shed its naked grain into the farmer's bushel or bin.

This extraordinary transmutation, it might be thought, could be the result of conscious selection. It could, if the selector were one who knew all that we know thousands of years later. But how could those first farmers have known what evolutionary changes were possible? And how could they have foreseen how the rich harvests that lay ahead of them might be won?

There is, however, an even more striking example of the scope of unconscious selection. In general, the wild ancestors of crop plants have built-in mechanisms of self-incompatibility: genetic devices that prevent the pollen from growing in the styles and fertilizing the ovules of the same plant. These devices are necessary for the evolutionary success of all wild species for they insure that a proportion of the seed will be crossbred. In cultivation these devices cease to matter. They confer no immediate advantage; indeed they can only impair the yield. And, sure enough, they are nearly always lost in cultivation. For example, wheat and barley, peas and beans, which all allowed cross-fertilization in their wild ancestors are regularly self-fertilized in their modern cultivated forms. This change was made by selection, but it was not made by conscious selection, for until the last century no one knew it had happened; no one even knew that it could happen.

The cultivator who improved his crops did so, therefore, not by his intelligent practice of plant breeding, but by his intelligent practice of cultivation. And this was a capacity for which, we cannot doubt, the cultivator himself was continually being selected.

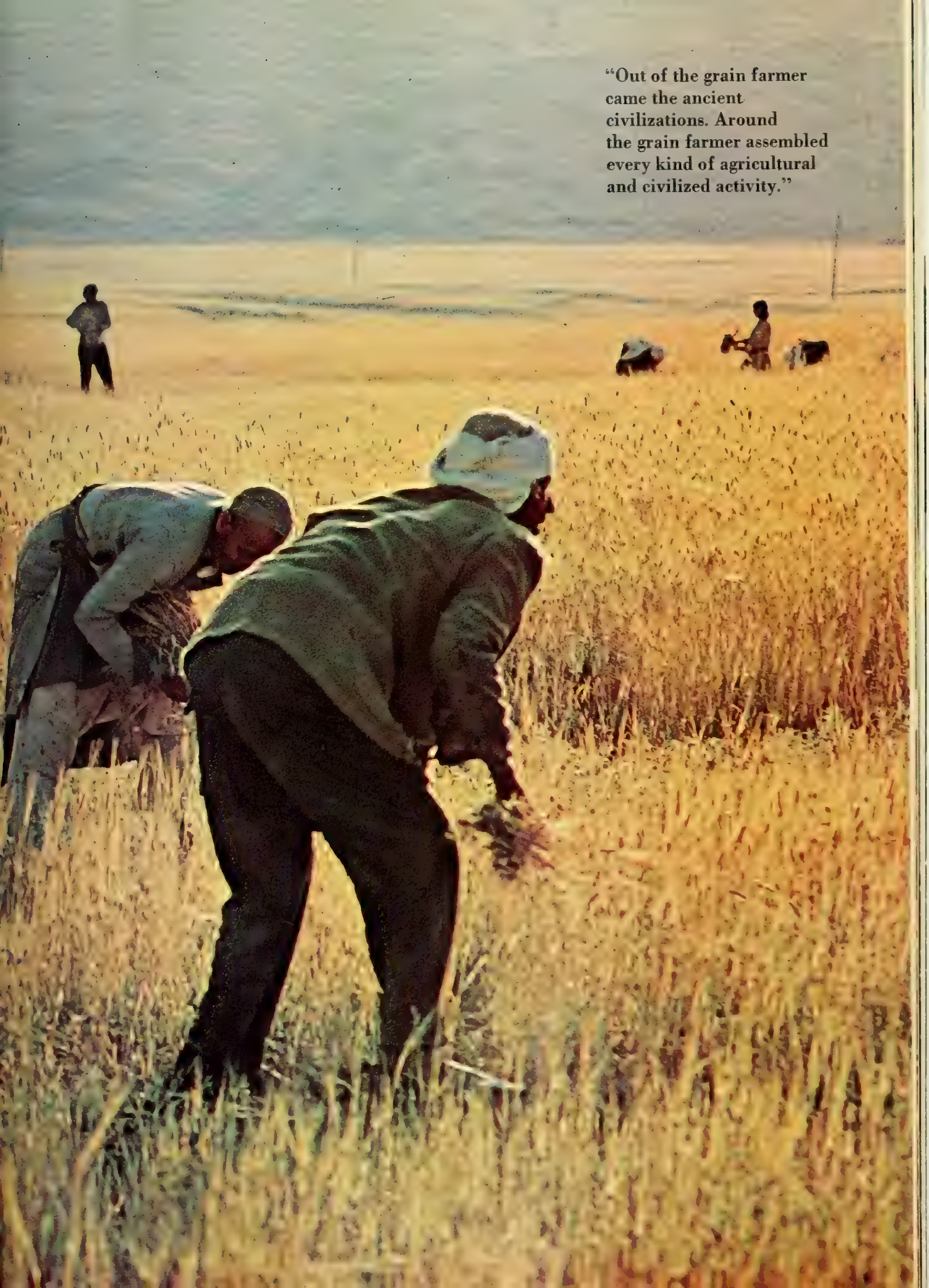
The contrast, indeed the conflict, between the tiller of the soil and the keeper of cattle, between the peasant and the herdsman, between Cain and Abel is so ancient and obvious that we naturally think of the domestication of plants and of animals as belonging to separate and opposed problems. But this is misleading. Out of the grain farmer came the ancient civilizations. Around the grain farmer assembled every kind of agricultural and civilized activity. Before grain farming, there was the collecting and even the cropping of roots in many parts of the world. Long before the grain farmer, there was the use of the dog for hunting, for food in time of famine, and later, for herding sheep and goats. But none of these activities led to a more complicated life, which in turn meant a more complicated, a stabler, and ultimately, a more productive society. No great development came about until the grain farmer had, during his four silent millennia, laid the foundations of the future.

The various kinds of stock and stockmen were therefore bound to have had different histories because of their different relations with the grain farmer. What these relations were are still partly obscure. The early settlements mostly contain bones of cattle, pigs, and sheep; but to what extent had these been bred and fed by the farmer and to what extent had he taken them by hunting? Did the early herdsman allow his domesticated female animals to mate with wild males or males that had gone wild? This is the practice of Nagas in India with their gaur cattle today. It is also the practice in mating dogs with wolves. The distinction between what is wild and what is domesticated is therefore harder for the archeologist to draw with stock than with crops.

Allowing for these uncertainties, we may say that sheep and pigs were probably the first to be taken under man's care, probably during the seventh millennium B.C. Later, in the sixth or fifth millennium, came the cattle. Whether their first use was for sacrifice in religious ritual will take us a long time to discover. But certainly this first introduction was quickly followed by their diversified uses for plowing, for milk, for meat, and later, in the salt-hungry regions of Africa, for blood.

When we come to the means of improving domesticated animals along their different lines, we can think of them together and we can see them in contrast with crop plants. The herdsman, it is clear, has from the beginning understood something of the purpose and practice of selection. Indeed we may say that the first herdsmen could never have improved their lot until they understood that better animals could be raised by choosing and setting apart better parents. It is a principle that is suitably and elaborately commemorated by the story

"The peasant is a man who knows and loves his soil and crops. . . . He and his women will accept serfdom rather than be separated from their land."



"Out of the grain farmer came the ancient civilizations. Around the grain farmer assembled every kind of agricultural and civilized activity."

of Jacob and Laban in the Book of Genesis.

The processes of animal breeding have thus been more conscious than those of plant breeding, and this has been true at every stage. For example, when the cultivators came into India in the third millennium B.C., they allowed their cattle to hybridize with the native humped cattle. This was no doubt an unconscious and merely traditional practice. But in the Indus city of Mohenjo Daro they also deliberately domesticated new species, notably the native water buffalo. Man's dependence on conscious purpose in dealing with animals as opposed to plants is further indicated by the length of time—five thousand years after the beginning of cultivation—that it took him to acquire the initiative, skill, and audacity to domesticate the most difficult animals, the horse and the camel.

If early farmers were sometimes aware of their effects on crops and stock, it is certain that they were wholly unaware of any effects their crops and stock were having on them (that is, beyond feeding, clothing, or working for them). But those who have observed peasants and pastoralists most closely have seen that between these two great classes of men, there is a genuine and profound contrast, a contrast related to their work. The record goes back, as we saw, to the legend of Cain and Abel, which takes its root in the conflict between the desert and the sown, between the Bedouin shepherds and their peasant neighbors. But on the way, it fills a large part of our history. It is the story of the borderland struggle between the English farmers and the Welsh drovers during the Middle Ages. It is also the story of the struggle between the farming Kikuyu and the grazing Masai in Kenya today.

How are we to describe it? In the first place it should be noted that each class is of many kinds. The nomadic pastoralist may sow crops for a quick harvest during his summer grazing, while the settled peasant may breed cattle or horses to till his land, a practice that has transferred the main labor of farming from the woman with a hoe to the man with a plow. The basic contrast remains however. It is one of character, behavior, and belief.

"The first herdsmen could never have improved their lot until they understood that better animals could be raised by choosing and setting apart better parents."

On the one hand, the peasant is a man who knows and loves his soil and crops. He even worships them. His life, like the lives of his ancestors for two or three hundred generations, has depended on his prudence and industry in handling the soil and crops. He is therefore deeply attached to them, and he and his women will accept serfdom rather than be separated from their land. As a consequence, they are inbred—conservative and traditional, stubborn but peaceful.

How different is the pastoralist! He is correspondingly attached to his animals, but his animals can move and usually have to move in search of pasture. He is therefore mobile, alert, and aggressive. He will steal the cattle and the women of his neighbors. Consequently, he is relatively outbred. And the most mobile of his animals, the horse and the camel, are kept by the most mobile and alert, aggressive and warlike, of herdsmen.

How, then, did this contrast arise? In part, of course, the differences were there in the ancestors, the collectors and the hunters from whom each was partly derived. But it developed during those long silent millennia because the earliest men who chose to adopt these different ways of life were themselves from the beginning dependent for survival on the crops or the stock they were raising. They were therefore dependent on their different abilities to cope with different ways of life. The croppers were in fact being unconsciously selected by their crops, and the stockmen by their stock. Each way of life was tied up together in one related and adapted system.

To put it in another way, man thought himself to be consciously in control of his destiny, but he was in fact unconsciously having his destiny, his evolutionary destiny, thrust upon him. It is a situation from which we can see he has not yet by any means escaped.

The greatest of all human experiments was man's invasion of the New World. Whether it happened fifteen or twenty thousand years ago does not much matter. What matters is that mankind had put himself into two separate boxes between which there was effectively no exchange of people or ideas, of plants or animals, or even of their diseases. That was the situation for over ten thousand years. And during that time, agriculture arose and developed independently in the two boxes. This was, as we may say, an experimental situation, for it goes a long way in showing us what matters and what does not matter for the whole process of developing agriculture.

Looking first at the similarities between the Old World and the New, it can be seen that in the New World, cultivation began around a kind of central or nuclear zone. It began about 7000 B.C., when the ice was melting at its fastest. And it began with a grain crop that the Europeans called Indian corn or maize. A variety of other crops—beans and potatoes, gourds and peppers, cotton and tobacco—slowly assembled around this early crop. But the processes of improvement and distribution show us a number of rule-breaking novelties. Several of these concern maize.

Unlike any of the other important grains, maize has its male and female flowers, the tassels and silks, on different parts of the plant. This has meant that the ordinary evolution toward inbreeding could not occur. Maize remained, and was bound to remain, crossbred. For that reason, it ultimately became the object of the most remarkable of all crop improvements: the American hybrid corn industry of the twentieth century turned an old shortcoming into a controlled advantage.

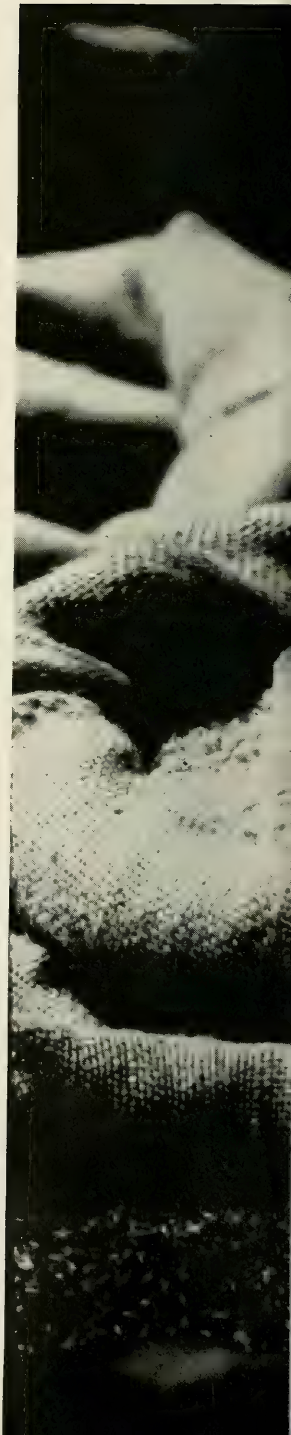
But maize is also unique with respect to its origin. No botanists would believe that maize was derived from a slender, wild Mexican grass, teosinte. Indeed they had put the two plants into different genera, *Zea* and *Euchlaena*. Yet when the hybridization is tried, the two species are found to cross readily. Their chromosomes pair in the hybrid. And, as Dr. Paul Mangelsdorf found, the hybrid is fertile, yielding the expected recombinations of characters in the second generation. Evidently the selection of mutations, probably conscious selection in this case, has produced the most remarkable evolutionary plant transformation known. All in the course of 9,000 years of cultivation.

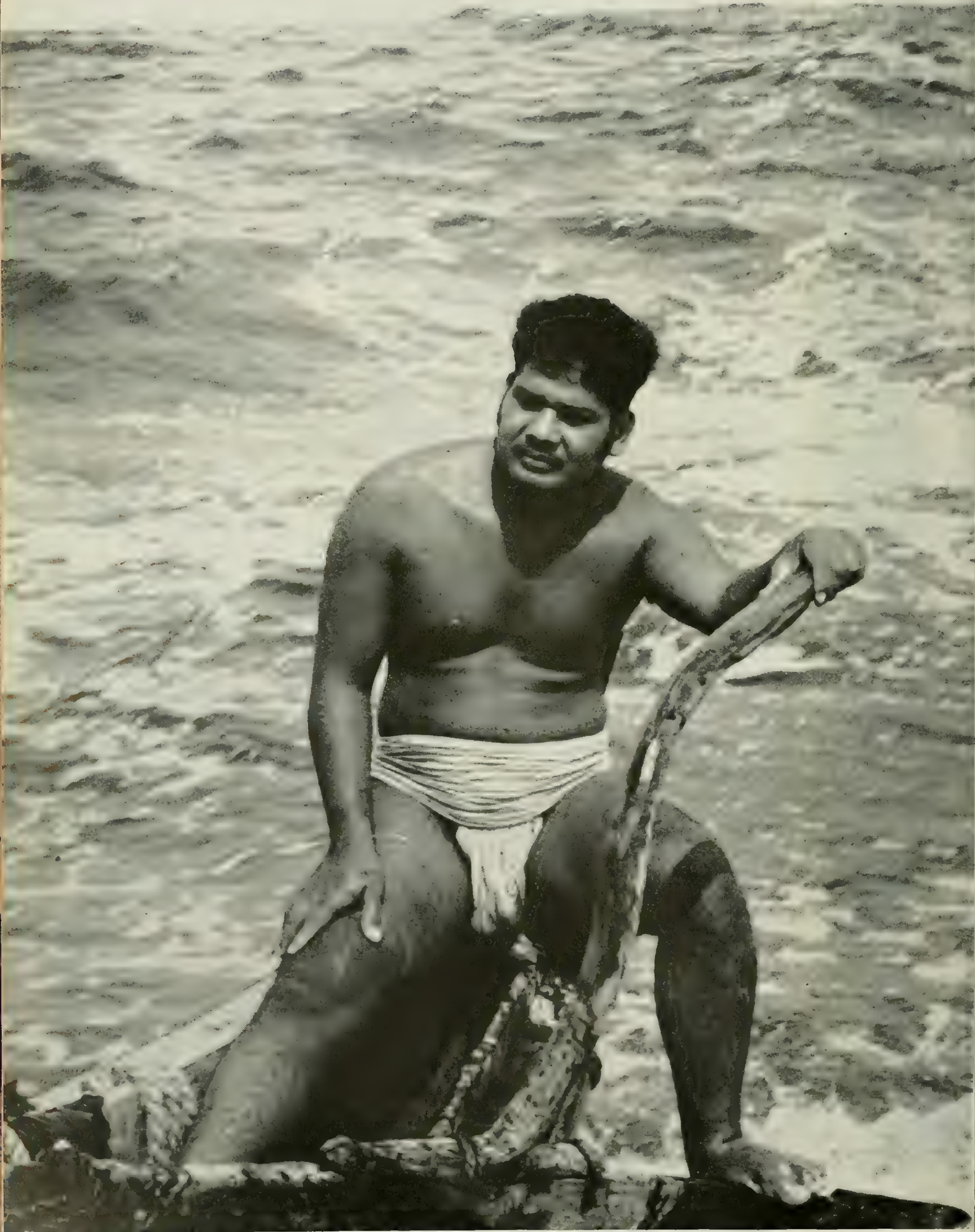
There is another American crop, the sweet potato, to which we owe an equally important piece of enlightenment. This plant, coming from Mexico or Peru, was already being cultivated across the Pacific all the way to New Zealand at the time of Columbus. The Maoris had brought it there from the mid-Pacific one or two hundred years earlier, and it had since become the main crop in the North Island. They knew it as *kumara*, the same name that it had borne in Central America. By their languages, their blood groups, their canoes, and their other crops, we know that the Maoris, like other Polynesians, came originally from Indonesia. It is the sweet potato that tells us that at some earlier time other people traveling westward from America had joined them. The two boxes of which I spoke had been almost entirely closed. But not quite.

The great difference between the Old World and the New, however, had nothing to do with these or any other crop plants. In the first place, the nuclear zone of America, instead of being a single, broad, and well-connected area, was split into two by the narrow, twisted 1,500-mile neck that runs from Tehuantepec to Panama, a track that had to be followed by everyone passing from North to South America. In the second place, stock raising was absent in America. In the previous five millennia the American Indian hunters had killed off what could have been the farmer's stock. Horses and mammoths were no longer available for domestication. All that were left were llamas and turkeys.

These two differences, together with the lesser area and resources of the New World, slowed down the development of agriculture and of civilization. The silent millennia were longer. When the two worlds were brought together in 1492, the civilizations of the New World were found to be about three millennia behind those of the Old World. Mexico and Peru proved to be not unlike the Egypt of Hatshepsut and Thutmose in 1500 B.C. The consequences of this difference in evolution, the submergence of the Amerindians, are with us now, but they are beyond our present inquiry. They show us, however, in a practical way, the overwhelming importance for us today of what happened during the distant years when men and women first began to hoe the earth and sow the seed.

"Along with the two wheats, a variety of other food plants were cultivated, a variety that increased with the passing of time."





Part II

EAST IS A BIG BIRD

"You steer by the shape of the sky. You are sailing into a part of the heavens, not toward a dot of light."

by Thomas Gladwin

Picture yourself on a Puluwat canoe at night. The weather is clear, the stars are out, but no land is in sight. The canoe is a familiar little world. Men sit about, talk, perhaps move around a little within their microcosm. On either side of the canoe water streams past, a line of turbulence and bubbles merging into a wake and disappearing in the darkness. Overhead there are stars, immovable, immutable. They swing in their paths across and out of the sky but invariably come up again in the same places. You may travel for days on the canoe but the stars will not go away or change their positions aside from their nightly trajectories from horizon to horizon. Hours go by, miles of water have flowed past. Yet the canoe is still underneath and the stars are still above. Back along the wake, however, the island you left falls farther and farther behind, while the one toward which you are heading is hopefully drawing closer. You can see neither of them, but you know this is happening. You know too that there are islands on either side of you, some near, some far, some ahead, some behind. The ones that are ahead will in due time fall behind. Everything passes by the little canoe—everything except the stars by night and the sun in the day.

We can call this a figure of literary style, a canoe pictured pushing through the sea with everything moving past it except the stars poised overhead. For the Puluwat navigator it is not a matter of style. It is a convenient way to organize the information he has available in order to make his navigational judgments readily and without confusion. This picture he uses of the world around him is real and complete. All the islands which he knows are in it, and all the stars, especially the navigation stars and the places of their rising and setting. Because the latter are fixed, in his picture the islands move past the star positions, under them and backward relative to the canoe as it sails along. The navigator cannot see the islands, but he has learned where they are and how to keep their locations and relations in his mind. Ask him where an island is and he will point to it at once, probably with considerable accuracy. Puluwat navigation is entirely a dead reckoning system. It depends upon features of sea and sky which are characteristic only of the locality in which it is used, that is, the chain of islands in the Western and Central Carolines from Yap to Truk and the Mortlocks.

Navigation by dead reckoning means that one's position at any time is determined solely on the basis of distance and direction traveled since leaving the last known location. Put the other way around it means that if you lose track of how far you have come from where you were, you are lost. In contrast to this, Western celestial navigation, loran, and other techniques make it possible to establish a precise position without any knowledge of where you have been, except in the most general sense of knowing what part of the world you are in. The latter methods depend, however, on a very complex technology, either of timekeeping and star-tracking or of electronics. Yet dead reckoning is inherently no more or less accurate than they are. If there are available sophisticated techniques for keeping track of direction and distance traveled, it is possible by dead reckoning alone to establish a position with great precision. Inertial navigation, for example, is a system solely of dead reckoning which is widely used as a primary method of navigation on everything from submarines to missiles, and a lot of ships and aircraft in between. True, with less sophisticated technology the accuracy of dead reckoning declines. Yet it must be remembered that none of the Western techniques are even conceivable in the absence of a complex technology. Celestial navigation had to await astronomy and the engineering marvel which is a chronometer, while loran and other still more sophisticated techniques were born only in the last quarter-century of our electronic age.

Successful navigation from one island to another under a system of dead reckoning falls into three phases or sets of tasks. First, one must set out in a direction such that, knowing the conditions to be expected en route, one will arrive in the vicinity of the island of destination. Second, while on the way to this island the canoe must be held steady on its course and a running estimate maintained of its current position. Finally, when the craft is

ailing downwind, a Puluwat teersman uses his foot o hold the steering paddle lown and deflect it.

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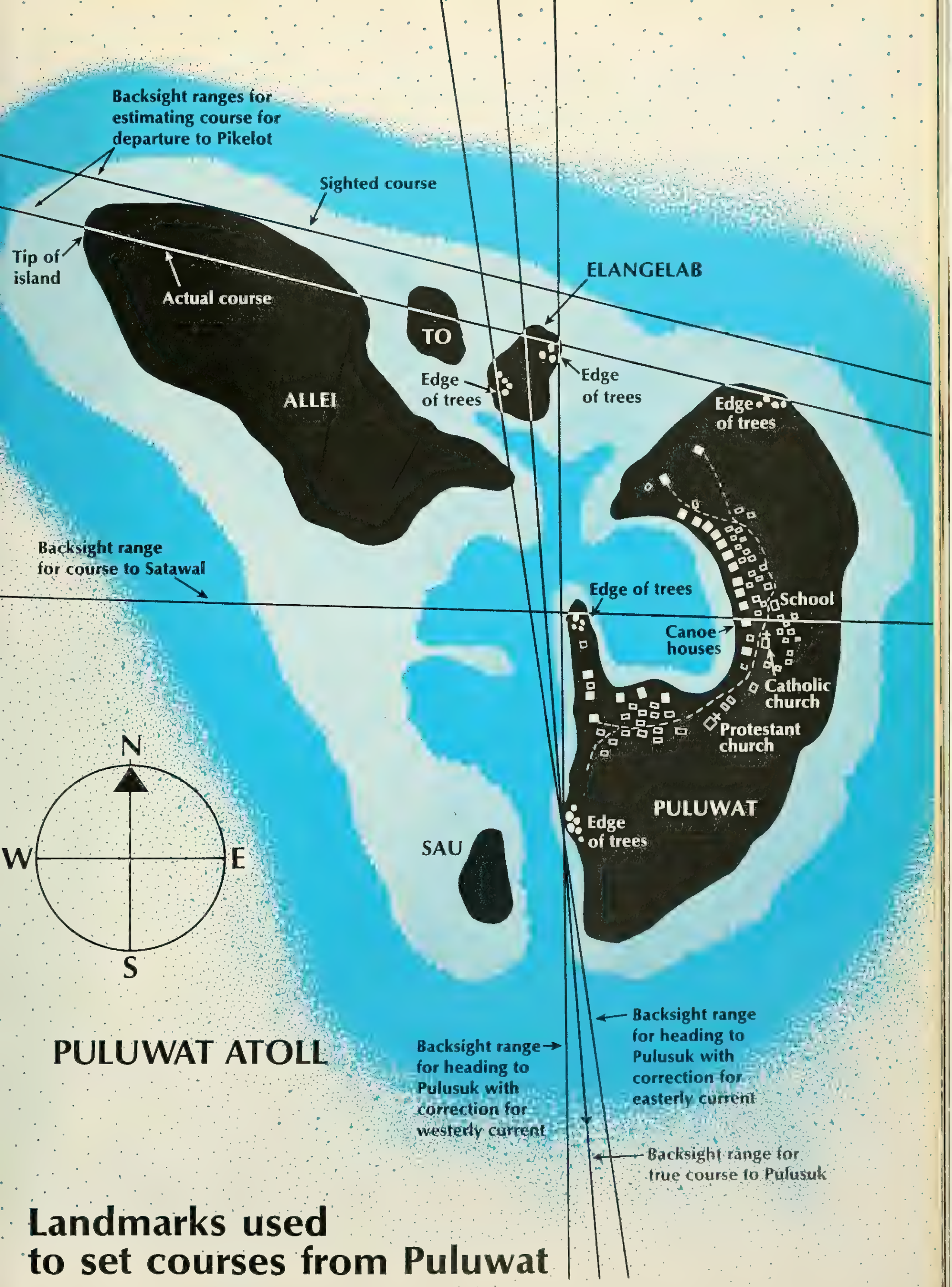
near its goal there should be available techniques for locating the destination island and heading toward it. If the system is to work, it is necessary that the amount of absolute error introduced during the first two phases, that is, in the initial heading and the en route course, be less than the maximum range at which it is possible to locate and home in on the final island. In other words, when you are heading for an island you must be able to come close enough to it to find it.

Central to Puluwat navigation is familiarity with the positions where the stars rise and set. The stars, as we all know, rise in the east and set in the west, as do the sun and the moon. Away from the equator, as in the United States and Europe, they rise above the horizon at an angle and describe a sloping arc through the sky, an effect produced by being located toward the "top" of the spinning globe. Near the equator, however, the stars appear to rise and set vertically, except those in the extreme northern and southern sky. This means that even though a star is sighted some distance above the horizon, it is nevertheless almost directly over the spot where it has risen or where it will set. It is this quality of vertical movement in equatorial stars which has been observed and used by Carolinian navigators. They have selected various stars both for their prominence and because the places of their rising and setting are spaced around the horizon. In this way, the sky on a clear night becomes a vast compass, the various headings picked out by familiar stars as they move up and down near the horizon. Yet the particular star which is named and stands for a given bearing is visible in a setting or rising position only part of the time. At some seasons it does not appear at all. Even when it is visible it spends part of the night so high in the sky that it is not possible to obtain a bearing by looking at it. For these reasons other stars are noted and remembered which are at the same celestial latitude—"travel the same road"—and can therefore substitute for the named navigation star when it is unavailable.

Thirty-two directions or bearings are defined by the navigation stars, which happen also to be the number of points on a traditional mariner's compass. The thirty-two stars in the Puluwat navigation system are, however, historically much older than the advent of the Western compass in this area, and are therefore not derived from it. Although the stars are spaced around the horizon they are not exactly the same distance apart, and therefore do not quite coincide with the points of the mariner's compass.

On Puluwat the cardinal direction is east, under the rising of Altair, the "Big Bird." However, the star compass system can most readily be described to a Westerner by beginning with the North Star, Polaris, "the star which never moves." The North Star is low at the latitude of the Carolines, roughly 7 degrees north, and frequently obscured by cumulus clouds which often ring the tropical horizon even at night. Nevertheless, it is highly valued because it is always there and, being close to the horizon, can provide a good bearing when sighted. Near the North Star, and thus rising a little to the east of it, is the Little Dipper. Being so far to the north, the Little Dipper swings in a fairly tight circle about the North Star and does not stay directly over its point of rising for as long as the other stars do. It has the further disadvantage of being a constellation of several stars, although its brightest star, Kochab, catches the eye and provides the most obvious bearing. Just as the Little Dipper rises a little to the east of the North Star, so it sets to the west by an equal amount. Therefore, like most other navigation stars (or constellations), it defines two points or bearings on the circle of the horizon, its positions of rising and setting being equal amounts to the east or west.

Next around the circle of the sky both east and west (rising and setting) come two large constellations, the Big Dipper and then Cassiopeia. Although the Puluwat navigator does not include in these constellations precisely the same stars which we do, each still covers a great deal of the sky. If they were swung toward each other around the pole without changing their latitude to north or south they would overlap. How, then, with their great extent and their overlap can they provide the navigator with clearly defined bearings distinct from each other? The answer appears to be that they do not. In the south the situation is little better. Due south is located by the Southern Cross in its upright position. When in this position the Southern Cross is a little too high in the sky for a really good bearing, but otherwise it is satisfactory: it is actually very close to true south and is a neatly symmetrical cross whose center is unambiguous. But the next position to one side, corresponding to the Little Dipper in the north, is the same Southern Cross leaning over at approximately 45 degrees, and next to that is the Southern Cross yet again, lying on its side as it rises and sets. The disadvantages of this arrangement are obvious. I was puzzled through most of my stay on Puluwat by this, which seemed to me sloppy and vague in a system otherwise so precise. However, the more I pressed for the same consistency and rigor in the northern and southern extremes of the star compass as obtains in the remainder, the more the people I asked became confused, and so did I. It was not until I took my instructional voyage to Pulusuk and back with Hipour, a Puluwat navigator, that I realized the dilemma was created by a different set of expectations of the system on my part and on theirs. I took it for granted that a star "compass" that formed the heart of a demonstrably accurate system of navigation must itself necessarily be accurate—in all its parts. In actuality, however, the Puluwat navigator requires of his star compass only two qualities. First, it must be systematic enough


Backsight ranges for estimating course for departure to Pikelot
Sighted course
Tip of island
Actual course
ELANGELAB
TO
Edge of trees
Edge of trees
ALLEI
Edge of trees
Backsight range for course to Satawal
Edge of trees
School
Canoe houses
Catholic church
Protestant church
PULUWAT
Edge of trees
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PULUWAT ATOLL
Backsight range for heading to Pulusuk with correction for westerly current
Backsight range for heading to Pulusuk with correction for easterly current
Backsight range for true course to Pulusuk

Landmarks used to set courses from Puluwat that it can be explained and taught. The named star positions ranged around the horizon serve this purpose. Second, it must be sufficiently accurate to guide him to any destination he needs to reach, but gains nothing from being more accurate than is necessary. It is the latter that I was slow to recognize.

The return trip from Pulusuk to Puluwat was intentionally made largely at night. The course was nominally just west of north—toward the setting of the Little Dipper—but in order to make good this course against a westward current and a generally northeasterly wind we held a heading as close to north as possible during much of the journey. Small cumulus clouds were scattered across the sky but, except when distance made them appear to bank up at the horizon, they did not interfere with periodic star sightings until the weather turned bad near the end of the trip. The Little Dipper was up, but was rising during the early hours of the night when we were watching the stars. Thus it was on the wrong side of the North Star for our purposes. The North Star was up as always, but the clouds and some haziness made both it and the Little Dipper hard to keep in sight. The Big Dipper, however, was high and sparkling bright.

As we sailed along through the beautiful night, the wind just right, the sea not too rough and glistening with splashes of phosphorescence, I was watching the stars and asking questions. Occasionally the North Star would shine through the clouds slightly to the right of the heading of the canoe. Even when the North Star was obscured, the Big Dipper was there above the clouds, at least part of it in sight all the time. The two "pointer" stars of the Dipper showed where the North Star was hidden. I soon became used to how the Dipper lay and unthinkingly shifted my attention from the North Star's projected position to just the Dipper alone in gauging when we were on course or off. Then I realized that in this northern part of the sky, where all the significant stars are more or less bunched together, it is not necessary to have a discrete point on which to set a course. Instead, to borrow an expressive image from the Mississippi River pilots of Mark Twain's day, you steer by the shape of the sky. You are sailing into a part of the heavens, not toward a dot of light. This must be even more true on a southerly heading, because much of the time the extreme southern sky holds only one bundle of significant stars, the Southern Cross. In both cases the configuration of the stars is sufficiently distinctive that one can estimate a course with considerable ease and accuracy. This procedure would not be sufficiently precise for a long voyage, but in the Central Carolines almost all north–south trips are conveniently short.

Moving south from Cassiopeia through a fairly wide arc of the sky devoid of navigation stars, we come to the first of a succession of individual stars or small constellations which occupy positions fairly close together in the eastern sky at their rising and, correspondingly, in the western sky at their setting. There are nine closely grouped star positions, beginning with Vega on the north and ending with Antares on the south. When these nine rising positions are combined with their setting counterparts on the west, they embrace in the intervals between them sixteen, or half, of the thirty-two intervals into which the entire star compass is divided. The arc, however, between these same stars is only about 66 degrees on either side, adding up to little more than one-third of the whole 360-degree circle of the sky. This bunching together of star positions to east and west, as well as the precision possible with single bright stars or such compact constellations as the Pleiades, reflects the greater demands for accuracy which are placed on the navigation system as a whole by longer east–west passages.

In the middle of this arc, rising due east, is Altair, the "Big Bird." Just to the north and south of Altair—in the same constellation which we in the West also call a big bird, the Eagle—are its wings, Gamma and Beta Aquilae. Altair is where the count of stars on Puluwat begins, the greatest navigation star of all. Although it actually rises and sets 7 degrees north of the equator, because Puluwat is 7 degrees north, Altair always bears true east and west. Not only that but it has two bright companion stars, Procyon and Bellatrix, on almost exactly the same latitude but around on the other side of the heavens, so that when one is down another is up. Between the three of them, they can provide a rising or setting bearing at almost any season or time of night. Altair is the star for Satawal to the west and Truk to the east, the two longest passages Puluwat navigators regularly make without intermediate stops.

Altair is not the only navigation star which has alternate companion stars around the sky at the same latitude, that is, rising and setting at the same locations. A number of other stars have at least one substitute, and for almost any position there are other recognized stars which rise and set close enough to the right or left of the position of the navigation star when it is not itself up to provide at least an approximate bearing. Furthermore, it is not necessary that the star that is going to be used lie straight ahead. A sight to the rear will serve as well because the navigator is concerned only with lining up the heading of the narrow hull of his canoe with the star. He can do this by looking in either direction.

The foundation of any sailing plan is the star position which provides a bearing between the destination island and the island from which the journey begins. Satawal is due west of Puluwat so the star course is "under," as the Puluwatans express it, the setting of Altair. Pikelot, northeast of Satawal, lies under the setting of Pleiades from Puluwat. One can go on around the islands which, near or far, encircle Puluwat, calling off the course star for each. A similar round of star courses to other islands can be recited for each of the islands in the area, and every navigator knows them all.

Although the nominal star course between any pair of islands usually reflects the true bearing between them, this true course in some cases is virtually never used, at least at the start. A deviation of one star position, sometimes even two, is often introduced to compensate for, or take advantage of, characteristics of the seaway between the two islands. Compensation is principally for the effect of currents. The run of prevailing currents throughout the seas ranged by Puluwat canoes is known to navigators. Compensation for these currents is an integral part of the package of instructions which comprise the sailing directions between island pairs. The initial course from Puluwat to Satawal offers a good example. Satawal lies under the setting of Altair. However, one usually starts out one star position to the south of this under Beta Aquilae to counter a strong current which sets from the southeast in this area. Yet sometimes even this is not enough.

Apprentices use circle of pebbles to represent stars in a study session with an elderly navigator.

In this part of the Pacific Ocean there is great variability in currents. To the north, the North Equatorial Current runs westward, while to the south the Equatorial Countercurrent goes in the opposite direction. The Caroline Islands not only lie along the line of transition between them, but here too a large proportion of the Countercurrent is actually generated by a reversal of the North Equatorial Current. Thus there are both vast eddies and abrupt changes in the direction of the currents which occur almost from day to day. Part of the routine for departure on a trip, therefore, is to gauge the direction and rate of the current before losing sight of the fixed positions of the island and its surrounding reefs.

The other major element in the sailing directions between island pairs are the seamarks en route. The most common seamarks are reefs. There are extensive reefs throughout the Central Carolines, although they become rare to the south. In general they are 60 to 120 feet below the surface at their edges, often deeper toward the center. They range from the great complex of the Gray Feather and Mogami Banks, which together extend more than a thousand square miles under the ocean, to single isolated heads of coral which cap hidden pinnacles risen from the ocean floor. Because of the clarity of the tropical water and its subtle shadings in sun and shadow, the reefs, despite their depth, can readily be detected from a canoe. This is true even when the wind is blowing the surface of the water into spume. In addition the current running over a reef roils the water and steepens the waves. Thus in the daytime a reef can often be detected a mile or two away by the whitecaps it creates, while at night it imparts a special uneasiness to the motion of a sailing canoe. The suspicion of a reef which this uneasiness engenders can readily be checked by a sounding with the fishline which is always on board.

Once over a reef it is possible to determine one's position. Often passing over a reef is part of the sailing plan and sighting it below verifies that the canoe is on course. At other times the canoe might be lost or uncertain of its position. Then it is necessary to sail along the edge of the reef until its bearing and some of its outline can be established. In the middle of a reef there is no way to tell one from another, but every reef has its unique outline. The skilled navigator knows them all. Therefore, even if dawn breaks and finds him in the center of a big bank he need only sail off in almost any direction to find its edge. Then by traveling along it for a way he can determine which reef he is over and his location along its perimeter.

Thus reefs can serve not only as guideposts along the seaway to an island but also as a screen to arrest a canoe if it has strayed from its course, or perhaps even gone past its destination. If a navigator who is not expecting to pass over a reef sights one under him, he stops and casts about to find out where he is. Even more is this true if he should sight an island other than the one toward which he is heading. For this reason, whenever possible a course is set so that reefs, or better still islands which can be seen from afar, lie in a direct line beyond the destination, a screen to catch the canoe if it should miss its mark. This is far safer than a course in which there is only open ocean beyond and illustrates an essential characteristic of Puluwat navigation: sailing directions are always conservative, incorporating every precaution the seaway can offer.

From every island there are seaways radiating in all directions. Each has its unique set of sailing directions designed not merely to set a proper course but also to include every special precaution the arrangement of islands and reefs

Interisland and paddling canoes are pulled up along the shore; two canoe houses nestle in the trees.

will permit. All of them are stored in the memory of the navigator. As his canoe moves away from the island, even though he may have given no thought to his itinerary until that moment, he already knows exactly what he should do and the course he should set.

Usually this departure occurs in broad daylight. Worse still, all preparations for a trip are likely to be finished about noon, the most elusive time of day for establishing a course. At this hour there are not only no stars but even the sun is near its zenith and useless for determining direction. However, the island which the canoe is leaving usually can provide enough information for at least a preliminary heading. As the canoe sails away the navigator looks back. He has learned how the island should look from a canoe as it heads toward each of the various islands to which he might journey. For shorter trips the general configuration of the island provides sufficient orientation to set a course. However, for more precision there are usually two points visible from the sea which are directly in line with each possible island of destination and thus provide ranges to sight along. Puluwat is especially handy for this purpose because the complex of closely spaced little islands which forms the atoll offers a multitude of distinguishable landmarks to be lined up one behind another. By sailing so that they remain in line the navigator who knows his backsight ranges can keep his canoe steadily on course for its destination until the island drops out of sight.

A heading can also be established in some directions by passing over designated portions of reefs near the island of departure. The reefs around Puluwat offer little orientation, partly because the principal reef, Uranie Bank, stretches off to the southeast, a direction in which no islands lie. Its northern edge, however, runs due east from Puluwat and sailing along here a canoe can line up exactly on course for the main pass into Truk. As a consequence, no land-based backsight is necessary for Truk when departing from Puluwat.

Backsight ranges and orientation courses over reefs serve two purposes. One is to establish the force and direction of any current which may be running. Once away from the fixed reference of land or reefs there is no way to estimate the current, or even to know whether one is running at all.

The other is to set a course when neither sun nor stars are available at the time of departure. Such a

Before changing course, crewmen move the sail from one end of the canoe to the other.

course once set can be maintained by use of a compass and by observation of the waves until either sun or stars come into view close enough to the horizon to define a more accurate heading. In the past only the waves could be used for this purpose. Now the waves are still observed as a check and an alternative to the compass. The six to eight miles through which the backsight landmarks can be seen and utilized are barely enough to average out the compass readings, to emerge into an area of clear ocean waves free of interference from the island, and to verify that the course being held with compass and waves is a true course. Once this has been done the task of the navigator moves into its second and longest phase, that of maintaining a course and knowledge of his current position until he is close enough to his destination to home in on it. Throughout the trip both the compass and waves remain available to provide a heading whenever the sun or stars cannot be used for this purpose.

The navigator alone watches the compass. This is obviously appropriate when the canoe is on a reach and the navigator is the one who is steering by trimming the sail with the sheet he holds in his hands. However, even when the canoe is running before the wind or is on a broad reach and steering is being done with the paddle by a man aft, it is still the navigator who watches the compass. The steersman is expected to observe the waves or keep an eye on a distant cloud. At intervals the navigator looks at the compass. If the heading is off he calls back to the steersman, "Come around this way, a little more, a little more . . . there!"

Thus the waves are still used even though, with a compass aboard, they need not be observed as assiduously or relied upon as fully as in the past. However, there are occasions at night when the sky is overcast and there is no light for the compass—no flashlight, no matches, no coals from a fire—and at such times the waves must be used exclusively to hold the course true. Despite its reduction to secondary status, the art of sensing direction by waves is thus by no means obsolete.

Hipour tends the sail from the navigator's platform, where he will sit for most of the voyage.

Three wave systems are recognized and used by Puluwat navigators in maintaining a course at sea. I have observed two of them, but the third kind of wave, which is weakest, was not running at any time I was out on a canoe. Coming from due east is the Big Wave (literally the "big, big wave"), relatively steep and short and quite distinctive once you have learned to recognize it. All manner of waves cross and impinge one upon another at various angles even far from land. Two or three crests go by, then another set intrudes from elsewhere. Yet the Big Wave has in a fashion difficult to describe more character. Perhaps the unbroken crest of the wave extends farther from side to side than do the lesser waves, or there are a few more crests which pass in review before a different set intrudes. These impressions are visual and untutored, and therefore inadequate. Puluwatans steer by the feel of waves under the canoe, not visually, so what I am able to report at first hand is several steps removed from the actual sensory inputs which guide the navigator on his way. My observations can thus testify only that the Big Wave is distinguishable, does come regularly from the east, and is therefore real, something which I found difficult to credit before I had been out on a canoe and seen it for myself.

The North Wave is the second of the major waves and actually comes in more from the northeast. Generally it runs a little east even of that, typically coming under Vega, one point east of northeast when the magnetic and star compasses are reconciled. It is a long swelling wave and would be called in English vernacular a ground swell. Other steeper waves crisscross its surface as it moves majestically past, sometimes on a calm day seeming to heave the entire surface of the ocean up on its broad crest.

The third, or South Wave, comes from a position correspondingly a little east of southeast, under Antares. It is much weaker and less regular in occurrence. I cannot describe it further because I have not seen it.

Because the Big Wave has a more pronounced character and passes with greater frequency it is preferred to the North Wave. Either is more useful than the unreliable and often weak South Wave. However, the choice of a wave depends not only on which one is running strongly but also on the course to be held. In general it is easiest to steer by waves which are either at right angles or parallel to the travel of the canoe. Waves met diagonally can be confusing. Let us say a canoe is sailing fairly straight into the waves. A wave crest comes along and lifts its front, then passes amidships. The canoe begins to pitch forward as the supporting water falls away from its front end. It is possible to sense quite accurately when the wave crest passes under the center of the canoe. Meanwhile the outrigger float is also riding over the same wave. It too rises and falls. If the canoe is headed exactly perpendicular to the wave the float will pass the crest at the same instant as the hull and there will be no sideways motion at all. If, however, the canoe is turned at even a slight angle to the wave, the float will pass the crest a trifle before or after the center of the hull. This will impart a discernible, even though tiny, roll to one side or the other. This roll need only be sensed for two or three waves in a row in order to define the bearing of the canoe in the wave system with considerable precision. As long thereafter as the roll remains the same, going over each wave in succession, it is certain that the canoe is holding its course. Correspondingly, a change in the amount and timing of this little roll can be translated into a precise amount of course change.

The principle is essentially similar when steering by waves which are coming from the side of the canoe. It is possible from the relative motion of hull and outrigger float to tell the precise moment when the hull is on top of a wave crest. If it is exactly parallel to the crest it will slide over without any pitching forward or aft. However, if it is at even a slight angle to the wave, the front or the back, as the case may be, will find itself out of the water and unsupported before the other end. It will drop a trifle, looking for water to buoy it up. Once again, then, there will be a characteristic movement, in this case a pitch forward or aft rather than a roll sideways, which will show not only that the canoe is not quite parallel to the waves but also in what direction and how far it is out of alignment. To steer on this heading requires only that the amount of and direction of pitch be kept constant from wave to wave. Needless to say, similar motions, slightly less clear because of pressure from the sides of the waves, occur in the troughs.

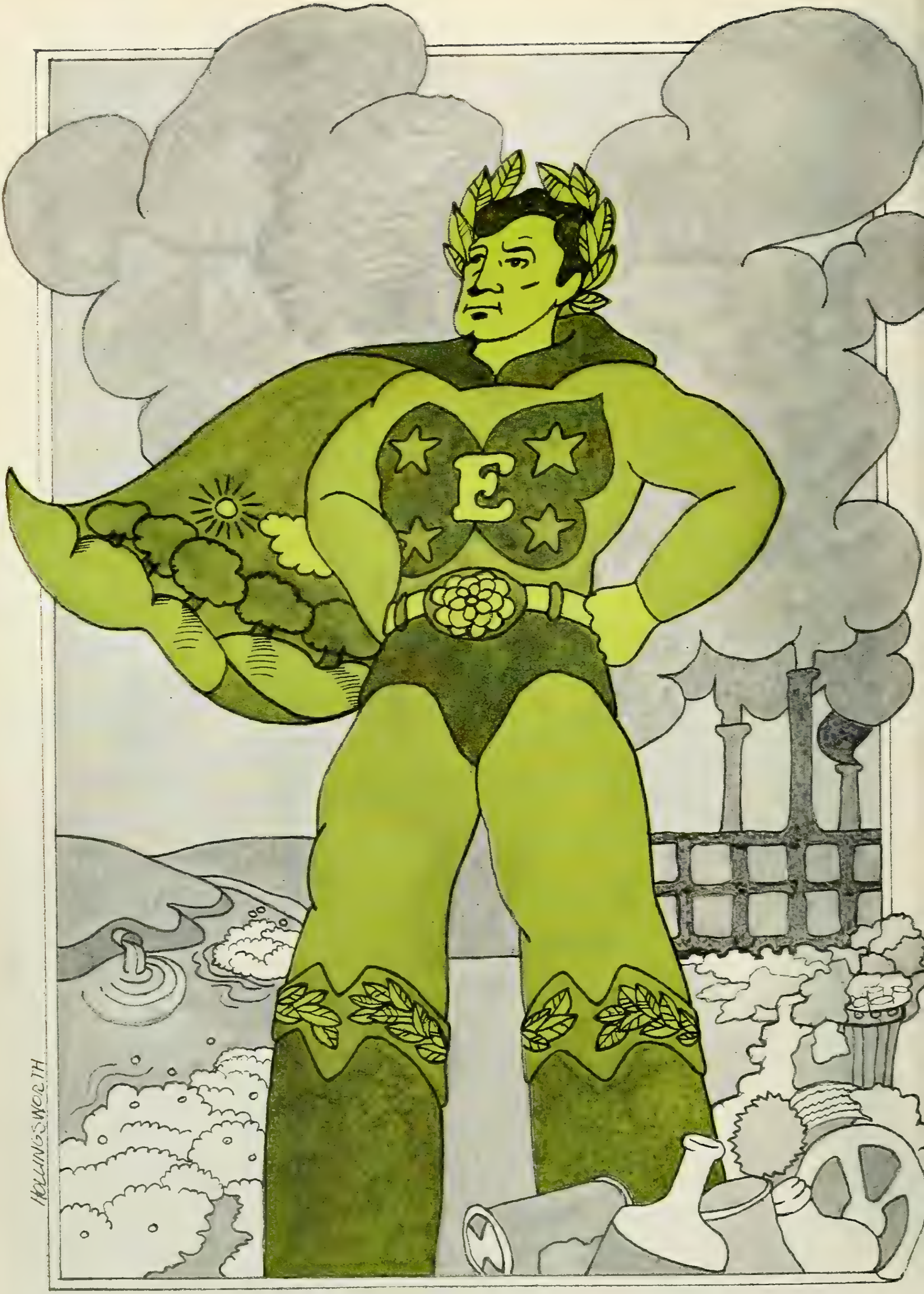
The range at which it is possible to home in on an island of destination determines the amount of error allowable in any navigation system. Navigation en route must be able to get the canoe close enough to its destination so that the navigator can find it with the techniques at his disposal. For the Puluwat navigator one technique for homing on an island which is out of sight is so heavily relied upon that it overshadows all others. This is observation of the flight of seabirds. True, there are others. Reefs can guide a navigator toward some islands. Telltale disturbances are occasionally noticeable in the waves. If freshly broken branches are found drifting they suggest that an island is near; this is especially likely after a storm, and storms are times when canoes can get lost. These signs are rarely used, however, because the seabirds locally available for observation provide such efficient homing that navigators do not need anything else.

Four principal species of seabirds—noddies, white terns, sooty terns, and one species of booby I could not identify—are relied upon for homing on an island which is out of sight. All share the essential qualities of sleeping on land at night and flying fairly directly toward this land at dusk and away from it at dawn. In addition, none range much more than twenty or twenty-five miles away from land as they wander over the sea during the day.

The homing range of seabirds can also be viewed in a somewhat different way. It has been referred to in terms of single islands. If instead one visualizes a twenty-mile radius of safety surrounding each of the islands in the Puluwat area, the resultant overlapping circles, each forty miles in diameter, will be seen often to stretch across the sea in long chains or screens able to intercept a canoe crossing them at any point. One such screen extends north and south with only one short gap, from Magur at the northern end of the Namonuito Atoll over one hundred and fifty miles south to Pulusuk. The gap results from the sixty-mile span of open ocean between Ulul and Pulap. This leaves an area perhaps twenty miles across without homing birds. However, a canoe sailing west through this area would almost certainly pass soon after over Gray Feather Bank and thus locate itself, so the hiatus is even less serious than it might appear.

A far longer screen emerges if the islands of this area are viewed as they would appear from the north. This view is of some historical interest because it is the view from Saipan. Seen from the north there is a continuous screen of overlapping bird ranges extending for three hundred miles from Gaferut on the west to Pisaras on the east. If one will concede to the longer-ranging boobies of East Fayu a capability almost to close the sixty-mile gap east of Pisaras, the screen can be extended more than a hundred miles farther east to Murilo in the Halls. This screen was used deliberately on the return from Saipan in the past when that voyage of over five hundred miles was occasionally made. Going north the canoe would make a final provisioning stop at Pikelot or occasionally Gaferut. Then it took off for the grueling ordeal of at least ten, usually more, hungry, thirsty days under the sun. The navigator sailed north until he was at about the latitude of Saipan, and then if he did not sight that island he turned west. Since Saipan is in the middle of a chain of high volcanic islands, many of them (including Saipan) quite large, he was bound to hit something. However, returning to the Central Carolines some months later there were no large islands to be sighted. Instead the navigator just headed south into the long screen of islands, reefs, and birds. He always found something—or if he did not, presumably he never told anyone about it!

The start of another voyage—crewmen raise the sail as the canoe moves out into the lagoon.


E
HOLLINGSWORTH

Captain Eco

Eco-Gemini: Two for the Teach-In

by Luther P. Gerlach

ECOTACTICS: THE SIERRA CLUB HANDBOOK FOR ENVIRONMENT ACTIVISTS, edited by John G. Mitchell. *Pocket Books, Inc., $.95; 288 pp.* THE ENVIRONMENTAL HANDBOOK, edited by Garrett De Bell. *Ballantine Books, $.95; 360 pp.*

Ecology is where the action is—some action, anyway, and much talk. Citizens' groups, scholars, government officials, national leaders, and, yes, even industrialists expound on the pressing dangers of environmental destruction. The media amplify and contribute to this alert. The president of the United States has endorsed the fight for a better biophysical environment, and as yet the vice-president has not publicly awarded environmentalists one of his witty labels of derogation and exclusion from the ranks of Middle America. Indeed, it almost looks as if this environmental movement is not an insurgent thrust at all, but rather an expression of the national will and spirit.

Everywhere people say that environmental concern will unite and save the country. For some the path to such salvation is clear: alert the public to the growing ecological crisis, then add money and technology, and Zap!—pollution is dead or at least pacified. In any event, Middle America is relieved to see its youth engage in the rites of ecology this spring instead of protesting Vietnam or promulgating revolution. Apparently mainstream Americans have not yet perceived that ecology, taken and applied seriously, *is* revolution, that it demands radical change: that ecology is "the subversive science" (as Shepard and McKinley label it in a book of the same name, Houghton Mifflin, 1969).

The ecology movement celebrated its first large-scale revival—or should we say "arrival"—this spring, the third week of April, 1970. At least two books were prepared for the occasion, presumably to contribute to the "talk" about environment and to suggest modes of action. These books are *The Environmental Handbook*, a Friends of the Earth book edited by Garrett De Bell (henceforth abbreviated *Handbook*), and *Ecotactics*, a Sierra Club book.

Many essays and comments in *Handbook* and *Ecotactics* spell out the revolutionary implications of the ecology movement, though perhaps not always with especial efficiency, tightness, or precision. But the message is there.

Of course, the message has been around for some time. For example, the radical left has for more than two years called for a radical restructuring of society to save the environment, arguing that destruction is a natural by-product of our present way of life, which must be remade if we are to have a living environment. Writers with this viewpoint, such as Keith Lampe of *Earth Read-Out*, contribute essays and statements for the *Handbook* and *Ecotactics.* It might be added that the Black Muslim press (in *Muhammed Speaks*) has also voiced similar sentiments, although as far as I can ascertain these contributions have not been included in the *Handbook.*

Side by side with radical statements that zero in on the need for revolutionary change, both books also include reports about the state of the movement and the characteristics of some of its outstanding or typical participants. For example, in an article in *Ecotactics* entitled "The Age of Ecology," Peter Janssen, the education editor of *Newsweek*, describes some of the types of groups and individuals in the movement. He does not tell us how long this age will last, but implies that the ecological revolution is here to stay because without such revolution man cannot survive. He further claims that "the ranks of the eco-activists cut across old traditional social and political lines, bringing together such strange barricade-fellows as short-haired athletes and long-maned hippies, the reactionary right and the revolutionary left." Such a coalition, he explains, occurs because these diverse individuals realize they share a common and deadly enemy, pollution. In short, Janssen implies that this movement can generate a rather broad-based unity. But he goes on to give some examples of nonagreement between student environmental groups and members of the general public. For instance, University of Arizona students protesting pollution from local copper mines found that "their issue was not overwhelmingly popular" because so many Arizonans "depend on the copper industry." Janssen seems to explain this schism on the "trouble . . . some activists have . . . in establishing any valid line of communication within the community." A cynic might say that Janssen is wrong—the students have succeeded only too well in communicating to the community and therein lies the trouble. They simply have not persuaded the community because of a very pragmatic conflict of interest. It certainly is not all that obvious to people that pollution is as much a threat to their survival as loss of employment.

Janssen refers to the work of *Earth Read-Out* editor Keith Lampe, and states Lampe's prediction that students will become more radical and militant in "arriving at" solutions to ecological problems. He also notes that another writer for *Earth Read-Out* "believes that students will increasingly adopt an anti-growth philosophy." These two propositions are, of course, repeated throughout the *Handbook* and *Ecotactics*. But, Janssen also notes that other observers of the movement say that most participants in the movement "aren't radical enough to consume less." In short, Janssen *should* be led to the proposition that his "strange barricade-fellows" will soon split, and present unity will dissolve. In this respect, a more recent statement by Lampe in the mid-March issue of *Earth Read-Out* is to the point: Lampe explains that, superficially, everyone from President Nixon down is all for saving the environment. But he sees this

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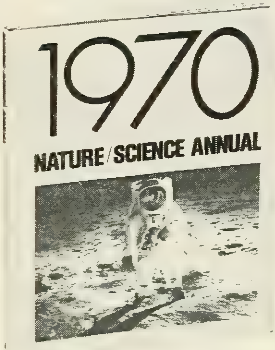

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as a sham, a red herring, which diverts people from the issue of revolutionary change. He ridicules the "hi-there" liberals who are playing the ecology game without being really committed to revolution. He asks the truly serious ecology radicals to stand up and show their revolutionary commitment by helping to "roll back the police state." Indeed, like other ecology radicals he states that the Teach-Ins themselves are so controlled by the liberal establishment that they are not to be taken seriously by revolutionary ecologists.

A study of movement dynamics will quickly reveal that this progressive fission within a movement is quite natural and predictable. Indeed, it is a defect in both *Handbook* and *Ecotactics* that the writers who report on the state of the movement, such as Janssen, do not go beyond mere description of that movement. What the volumes lack is a perspective essay on the general nature of social movements and their function in generating change. Within such a framework the ecology movement could be examined as one example of a class of events. Furthermore, it could be examined as one thrust of the much broader multirevolution (social, religious, ecological) that is transforming the United States. But, given the real function of these volumes as statements of the ideology and tactics of the ecology movement, perhaps such a perspective would seem out of place. Frequently, participants in a social movement consider their movement unique and resist its comparison with similar phenomena.

It must also be noted that, in addition to using a few new works, the *Handbook* reprints some ecology classics, while *Ecotactics* concentrates on new papers by students concerned with ecology.

Some of the essays feed coherently into the developing ideology of radical ecology. Some suggest areas of significant ideological and tactical difference within the movement and between it and established society. For instance, Garrett Hardin argues that man will not be motivated to decrease environmental despoliation simply by appealing to his conscience or warning him of impending disaster. (In contrast we have already noted that Janssen explains coalition of "strange barricade-fellows" on the grounds that everyone perceives the danger in pollution.) Hardin explains that instead man must be coerced by official restrictions if he is to be restrained from exploiting his environment to its death. Presumably this is to be done within the present system, using its legal mechanisms. John Gardner, now chairman of the Urban Coalition Action Council, notes that "our system of checks and balances dilutes the thrust of positive action" and seems to say that we had better get some powerful leadership from the top down if we are to get needed action. Does this also imply that our present system of checks and balances must be scrapped in favor of a more monolithic and totalitarian one? Gardner doesn't say this, but a fear voiced by the New Left is that some members of the establishment will use the ecology crisis as a means "to initiate massive programs within the [obsolete] frames of competitive society"; then assume dictatorial powers to protect the old order.

In comparison, Ralph Nader, in a provocative introduction to *Ecotactics*, suggests that necessary ecological change can be generated partly because the institutions that control America (corporations and administration) are in fact not monoliths but rather divided into diverse parts. He claims that the various groups within the ecology movement can change the system by penetrating it through those components that are sympathetic to ecology.

While accepting the cold realism of Hardin in evaluating conventional maximizing man, movement visionaries still feel that some people can be transformed and given an ecological conscience through radicalizing acts and identity-changing experiences. Gary Snyder's "Four Changes" certainly illustrates the steps of such transformation. And René Dubos in an introductory remark in the *Handbook* also notes the value of "romantic emotion" in powering a movement of ecological survival. He realizes that Environmental Teach-Ins function more to alert people to problems and define areas of concern than to provide new knowledge.

As noted, certain ideological themes do run through these books. These themes reflect the general development of ecology movement ideology, and their emergence was quite predictable a few years ago. We might identify a few of the major themes:

The Doomsday Theme: Some say we are in "the last days," others that we have "one last chance" for survival.

Guilt: To gain its high standard of living, the United States, more than any other nation, has sinned against nature by exploiting it, consuming resources, and polluting air and water.

The Concept of the Limited Good: The resources of the world are finite, and if we consume them, others will be deprived.

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The Concept of Closed System: The earth is, for all practical purposes, a closed system (a variant of the limited-good idea), a spaceship, as it were, with only limited amounts of life-sustaining energy.

The Need for Recycling: Recycling of outputs, which would otherwise be considered *waste*, is a necessity to maintain Spaceship Earth.

The Concepts of a No-Growth Economy and Zero Population Growth: This links to concepts about maintaining systems in a steady state; reducing consumption in an environment of limited good.

The Concept of Ecosystem and Interdependence: Environment and man interrelate dynamically. As yet popular awareness of ecosystem is at a rudimentary level and focuses chiefly on gross relationships between man and environment. There is little discussion or understanding of relationships among various sociocultural institutions or between sociocultural man and biophysical man.

The Acceptance of a Need for Marked Change to Save the Environment: Within this dimension there are, as suggested above, many divergent lines. The most obvious split is between those who would (*a*) endorse change within the system or (*b*) change the entire system radically.

The Concept That Individuals Must Commit Themselves to Change.

The Concept That System Change Also Means Change in Life Style: Here again we note a significant cleavage in the movement. There are those who say that individuals must "give up" many of the artifacts of a high standard of living—cars, extra electric appliances, and "labor-saving" devices. This seems a logical sequel to the concepts that man is approaching doomsday and must feel guilty about his sins against the environment. But this ethic of sacrifice is unlikely to have broad appeal. Far more attractive is the positive reward proposition that reducing his consumption gives man a chance to get off the treadmill and enjoy life in a better environment. In a *Handbook* essay, editor Garrett De Bell holds out the vision of such positive gains if only we change.

A useful comparison can be made here with the Black Power movement. A few black visionaries have argued that the changes promulgated by the Black Power movement offer white America—all of America—a better future. But in the main, blacks and whites ask for such changes on the threat of riot and destruction or by implication of guilt.

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It can be proposed that, given some of these concerns, the ecology movement will collide and conflict with the Black Power movement. For example, the rising expectations of blacks for a bigger slice of the American pie will clash with development of the concept of a limited good in a no-growth economy. Also, blacks see that the ecology issue diverts attention and resources from their plight. The ecology movement will also collide with those who wish to promote American industrial growth in other lands. And, of course, as noted above, very radical whites will become disenchanted with the liberal establishment's approach to ecology.

These two books do not really discuss this type of potential conflict. If the ecology movement is, indeed, to unite people in an honest and effective environmental crusade and not simply further polarize society, then participants must determine how to involve and include people from across the spectrum of American society.

In conclusion, we might speculate on the effect of these books. Certainly they provided grounds for discussion during the environment teach-in. Probably few readers will appreciate the revolutionary implications of many of the essays. The teach-in was a time of talk, not application. Everyone is on the ecobandwagon. At this stage of the movement, its rhetoric will not alarm.

As an aftermath of the teach-in there will be an increase in ecoaction, some of it directly sparked by suggestions presented in the *Handbook* and in *Ecotactics*. More car engines will be buried; more disposable bottles will be returned; some individuals will begin to consume less. This will not alarm the public, for few will take it seriously, few will believe that students really want to reject the automobile or to change their life style. After all, right now pollution protesters drive cars to meetings that are held, with all lights burning, in rooms filled with the cigarette smoke of those demanding that this or that power company stop despoliation of air and water.

Conflict will come later. It will come when present high expectations of environmental change are not met, when the general public is so supersaturated with talk of environment and pollution that it tunes out, when hard-core ecology activists really get to work, and when participants in the more radical groups call upon new recruits to demonstrate their total commitment.

Given the broad significance of these books it hardly seems fair to

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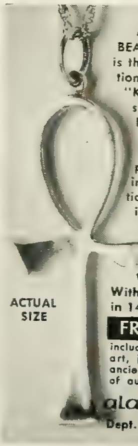

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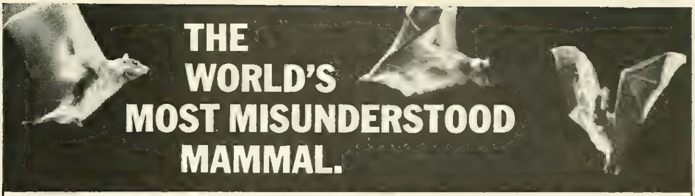
focus on some of their more technical defects. But perhaps some such critique is called for. It is unfortunate when editors of anthologies, even of anthologies hastily pulled together to meet a crisis, do not write those statements of introduction, transition, and summary that would give their collections needed perspective and interrelatedness. This would seem to be a very common failing of editors today. It is too bad that De Bell follows in such footsteps. He contributes some good essays to the *Handbook*, but he does not pull the total work together. Ironically, he includes and endorses an essay on the need for coherence in education, written by John Fischer (September, 1969, *Harpers*). Fischer says that a liberal arts education is not relevant because it is incoherent; it is incoherent because it consists of bits and pieces that don't stick together. Fischer claims that to make such education cohere, it should revolve around central concepts and problems, such as ecology. It seems equally clear that merely lumping essays together under one cover because they deal in various ways with what superficially is the same subject is not enough to make them cohere. Fischer would seem to know this, but does editor De Bell?

It is worth raising an additional question in this context: Robert and Leona Train Rienow contribute a chapter from their book, *Moment in the Sun*, to the *Handbook*. They mention the good work of Doctors Leake and Rusden who call for "extensive planting of trees and other green things to depollute the air," by converting carbon dioxide to oxygen. This sounds great, and surely tree planting would be a great pastime for budding ecology activists! But on page 72, in an article entitled "Energy," we learn something that is exactly the opposite: "a plant produces only enough oxygen for its own use during its life plus enough extra for the oxidation of the plant after death. . . ." Who wrote this? Why, Garrett De Bell, the editor. Surely, as editor he should have spotted something that seems so contradictory, and then set his readers straight so they know what to expect from so seemingly satisfactory an ecoaction as tree planting.

But let us not quibble about such minor defects and consider instead ways in which the concepts and suggestions contained in these two volumes can help us achieve a much needed ecological awareness, which, in turn, can lead to a more adaptive design for living.

Luther P. Gerlach is an associate pro-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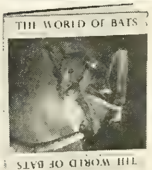

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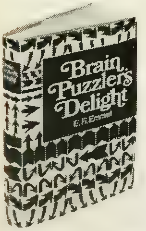

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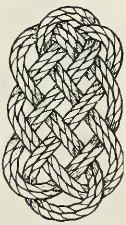

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SHIPWRECKS AND ARCHAEOLOGY: THE UNHARVESTED SEA, by Peter Throckmorton. *Atlantic-Little, Brown and Company, $6.95; 270 pp., illus.*

In a very real sense, underwater archeology was born less than twenty years ago when Jacques Cousteau began the extended investigation of a wreck discovered off the French coast near Marseilles. One of the pioneers of the new science is Peter Throckmorton. In this book, drawing upon his varied and rich experience, he sketches for the general reader what materials are available for the underwater archeologist to work on, what techniques he has developed, and what the future holds for this newly fledged field.

The underwater archeologist is primarily concerned with wrecks. Not all, however, are grist for his mill. In the opening chapters the author describes what happens to a ship after it hits the sea floor; how, and to what extent, it will disintegrate; and where divers can expect to find wrecks whose condition will warrant investigation. He relates his own experiences in working on remains found on coral or stone reefs, pointing out the special problems these present. He discusses the identification of wrecks, tells in detail of the tragic end of the *Nautilus*, a British sloop of war that went down off Greece in 1806, and describes how he was able to locate its remains.

The second half of the book concentrates on ancient wrecks. Throckmorton begins it by giving a comprehensive account of the 1901 excavation of the famous wreck off Anticythera that held a priceless cargo of Greek art. The work was more treasure-saving than excavation, and it was carried out entirely by sponge divers pressed into the service of archeology. Throckmorton has combed the newspapers of the time for information, and the story he convincingly reconstructs is considerably different from the official version. He then turns to the subsequent history of underwater archeology and explains the various techniques that have been devised to insure that underwater sites are excavated with the same precision as those on land. A prime problem is to mark and photograph a wreck in such a way that all objects are identified and their location recorded before they are removed. The solutions have ranged from painfully slow measuring and

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tagging by hand to the use of a special two-man submarine with waterproof cameras designed for stereophotography.

One particular motif runs through the whole book and is given extensive treatment in the final chapter—the sorrowful fact that much of the potential fruit of underwater archeology will never be harvested, thanks to the ruthless plundering of wrecks by treasure and souvenir hunters. The author cites one sad case after another of finely preserved wrecks that, within a year of discovery, had been viciously mutilated or picked clean.

Throckmorton is an enthusiastic and skillful writer who says what he has to say with speed and verve and in clear, nontechnical language. The illustrations are plentiful but, unfortunately, neither well chosen nor well reproduced.

LIONEL CASSON
New York University

SEEDS OF CHANGE: THE GREEN REVOLUTION AND DEVELOPMENT IN THE 1970's, by Lester R. Brown. *Praeger Publishers, $6.95; 205 pp.*

Over the past two years the press has been saturated with confusing and often contradictory statements concerning the "Green Revolution." The public has seen warnings of famine by some experts; warnings of food surpluses by others. Lester Brown was, at the age of 32, appointed head of the U.S. Department of Agriculture's International Agricultural Development Service. He played a major role in initiating the Green Revolution, and he is eminently qualified to write a book on the subject. He has written a fine one, indeed.

Seeds of Change will be welcomed by all those interested in the problem of feeding the burgeoning human population. It chronicles the development of new high-yield grains and describes early successes (and some failures) associated with their introduction to Asia. But the meat of this book is the discussion of how these early successes might be converted into a long-term triumph, a true agricultural revolution in the poor countries of the globe.

Considering his personal involvement, it is not surprising that Brown is enthusiastic about the potential of the new agricultural technology to bring about the needed transformations. It is to his great credit, therefore, that he gives very detailed consideration to the difficulties that must be overcome if long-term success is to be achieved. He discusses social, political, and eco-

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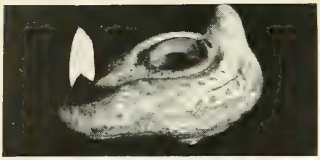

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nomic problems, pointing out critical areas and suggesting ways of avoiding trouble. For example, he urges great care in introducing mechanization into the agriculture of underdeveloped countries (UDCs), pointing out that agriculture must remain quite labor-intensive. The underdeveloped world, with roughly 45 percent of its population under 15, will have a high level of unemployment in the immediate future (as those children enter the labor pool), and many UDCs show extremely rapid rates of urbanization as well. Mechanization of agriculture, driving people off the land, would greatly exacerbate these problems.

Brown devotes a chapter to the population explosion, giving strong emphasis to the coming employment crisis. Unlike many other writers, he recognizes that the Green Revolution "is by no means a solution to the population problem [although] it is diminishing the prospects of famine in the near future and buying time—perhaps an additional fifteen years—in which to develop the technologies, the will, and the strategies to stabilize global population growth." Brown also makes clear his awareness of the role of agriculture in the problem of environmental deterioration, although the ways in which that deterioration may itself decrease available food supplies are not made explicit.

Although the book is brief, it contains a wealth of information—considerably more than its title would indicate. For instance, there is a fine discussion of some important agricultural problems in the United States. Examples are well chosen and interesting, and the clarity of the writing is outstanding. The book is suitable for any intelligent layman and is required reading for all professionals interested in the population-resource-environment crisis.

The tone of *Seeds of Change* is optimistic. Some people concerned with the population-resource-environment crisis, including myself, are more pessimistic. In my own case the pessimism stems largely from three sources. First, I feel the problem of environmental deterioration is probably the most serious we face, and that the actions of some "Green Revolutionaries" without Brown's insight may accelerate that deterioration. For instance, massive pesticide inputs in UDCs may seriously reduce the critically important harvest of protein from the sea. Second, I know that even the most dramatic, *immediate* success in the area of population control will not be able to halt population growth for many decades, and I am doubtful if any conceivable success with the Green Revolution can buy us that much time. And, third, I am enough of a cynic to believe that many of the very intelligent suggestions that Brown makes in the area of agricultural development will never be implemented. In addition, we are still a long way even from the first serious attempt to halt the population explosion, to say nothing of a successful program. But that I am more pessimistic than Lester Brown is not a criticism of *Seeds of Change*, which I recommend highly to anyone who is concerned with the problem of feeding a vastly overpopulated world.

PAUL R. EHRLICH
Stanford University

Briefly Noted

NIGHT OF THE GRIZZLIES, by Jack Olsen. *G. P. Putnam's Sons, $6.95; 254 pp., illus.*

This account of the events leading to the fatal maulings of two campers by bears in August, 1967, is perhaps the most hair-raising book of the year. Jack Olsen has assembled all the ingredients of this tragedy—the huge grizzlies whose free-roaming territory is being relentlessly eroded; the rangers who suspended park rules, better judgment, and common safety precautions; and the inexperienced campers and tourists to whom these bears were part of the "show." Actors and events are brought to a horrifying climax in a drama that the author believes may signal the beginning of the end for this carnivore. As Olsen says, "The grizzly needs space, and the continental United States no longer has space to give him."

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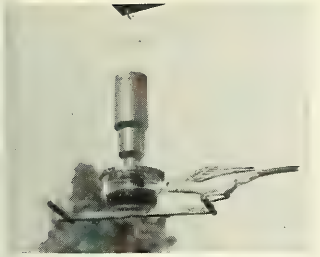

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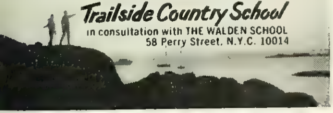

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Suggested Additional Reading

WHERE HAVE ALL THE BEACH CLUBS OF OLD HAVANA GONE?

Castro's Cuba, Cuba's Fidel. L. Lockwood. The Macmillan Company, New York, 1967.

Socialism in Cuba. L. Huberman and P. Sweezy. Monthly Review Press, New York, 1969.

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Nature and Man's Fate. G. Hardin. New American Library, Inc., New York, 1961.

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ANCIENT MEXICO AND CENTRAL AMERICA

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The Maya. M. D. Coe. Frederick A. Praeger, Inc., New York, 1966.

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Handbook of Middle American Indians. R. Wauchope, ed. University of Texas Press, Austin, 1964.

MIGRATION OF THE SPINY LOBSTER

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The Variation of Animals and Plants under Domestication. C. Darwin. 8 vol. D. Appleton and Company, New York, 1900.

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The Canoes of Polynesia, Fiji, and Micronesia. J. Hornell. Vol. I of Canoes of Oceania by A. C. Haddon and J. Hornell. Bernice P. Bishop Museum, Special Publication 27, Honolulu, 1936.

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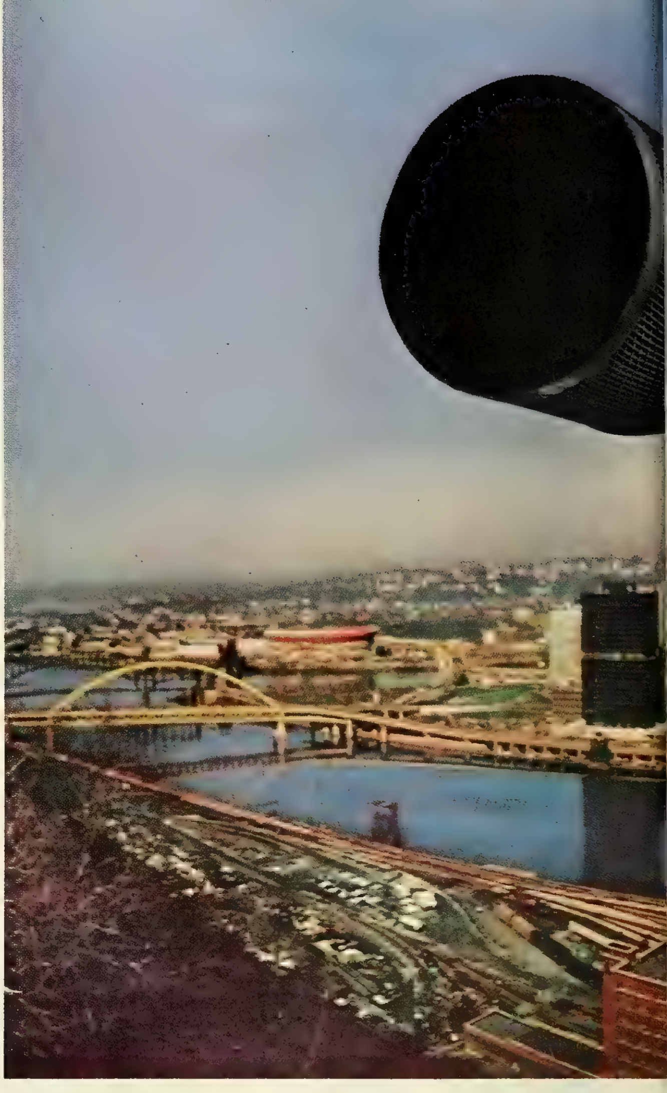
IBM's Dennis Leonetti, who began working on Allegheny County's long-standing air-pollution project in 1967, at the site of a planned sensing station.



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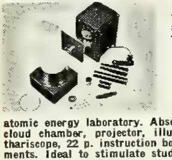

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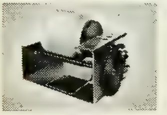

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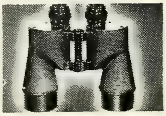

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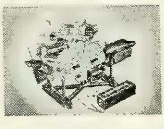

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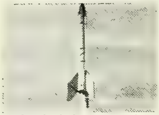

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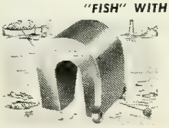

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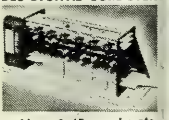

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NATURAL HISTORY

L. LXXIX, No. 6 INCORPORATING NATURE MAGAZINE JUNE-JULY 1970

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Publication Office: The American Museum of Natural History, Central Park West at 79th Street, New York, N.Y. 10024. Published monthly, October through May; bimonthly June to September. Subscription: $7.00 a year. In Canada and all other countries: $7.50 a year. Single copies $1.00. Second-class postage paid at New York, N.Y., and at additional offices. *Copyright © 1970 by The American Museum of Natural History. No part of this periodical may be reproduced without the written consent of* NATURAL HISTORY. *Manuscripts and illustrations submitted to the editorial office will be handled with care, but we cannot assume responsibility for their safety. Opinions expressed by authors are their own and do not necessarily reflect the policy of The American Museum.* NATURAL HISTORY *incorporating* Nature Magazine *is indexed in* Reader's Guide to Periodical Literature.

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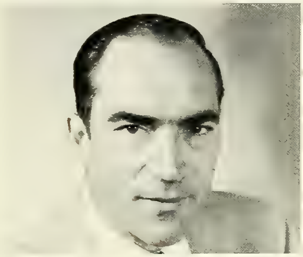

years Leopold's primary concern has been geomorphology—especially river mechanics and sediment movement—his research has included studies in climatology, soils, and hydrology.

Benjamin Franklin Professor of Anthropology and the History of Science at the University of Pennsylvania, **Loren Eiseley** also serves as curator of Early Man at the University Museum. His article, "The Star Dragon," is taken from

his latest book, *The Invisible Pyramid,* to be published this fall by Scribner's.

Since 1966 **George B. Schaller** has been a research associate with the Institute for Research in Animal Behavior of the New York Zoological Society and Rockefeller Uni versity. His article on the cheetah i based on a three-year study of th big cats in the Serengeti Nationa Park of Tanzania where he was member of the Serengeti Researc Institute.

Chistopher J. Schuberth is lecturer in geology at The Ameri can Museum and an adjunct le

turer in the Department of Geolog and Geography at Herbert H. Leh man College, New York. Based on fifteen-year study of Fire Island, hi article demonstrates how natura processes and human populatio pressures affect barrier reefs.

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Assistant curator of the Depart-ent of Entomology and In-ertebrate Zoology of the Royal ntario Museum in Toronto, **Da-id Barr** received his B.S. in iology from the University of To-onto. He went on to Cornell Uni-ersity, where he received his Ph.D. n entomology in 1969. Coauthor ith Denton W. Crocker of *The andbook of Crayfishes of Ontario*, arr plans further studies of water nite larvae.

Bob Skovbo is the pen name of he Canadian author of "Northwest assage." Born in Latvia, he stud-ed at the University of Manitoba n Winnipeg and at Carleton Uni-ersity in Ottawa. A lab technician n virology for several years, in 965 he went to the Northwest Ter-itories to work for a mining exploration company. Finding the country far too magnificent to work in, he returned the following year to simply travel and observe.

A native of Yugoslavia, **Paul von Baich** studied photography at the Vienna School of Arts in Austria. After having traveled and worked extensively in Europe, he went to Canada in 1960. Von Baich was the cameraman on documentary films made with the Austrian designer-writer Rudi Haas in Canada.

Peggy Young, the author of "Mushrooms," operates a one-woman photographic business that specializes in children's portraits. Her interest in mushrooms grew out of a photographic assignment of a purely compositional nature. She is currently at work on a collection of photographs of west coast wildflowers.

Associate professor of anthropology at the University of Minnesota, **Luther P. Gerlach** and his students have, since 1965, conducted research on movements of social transformation. He is currently producing a film about the ecology movement entitled "People-EcoAction." A research associate of Gerlach's since 1965, **Virginia Hine** is coauthor of *People, Power, Change*, their book on social movements.

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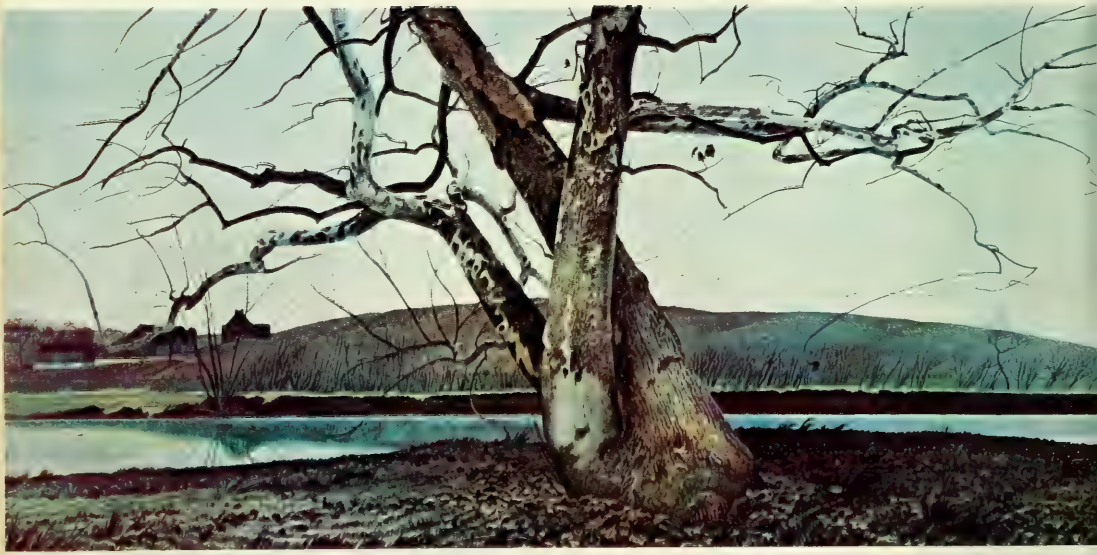

Buttonwood Tree
Andrew Wyeth, 1941.
Courtesy of Alfred E. Bissell

Or, to continue with Burns, how the best laid environmental schemes of men "gang aft a-gley"

r the Upper Brandywine

by Luna B. Leopold

Perhaps the most lamentable mis- ke that one can make is to be ght too soon. This was the story the Brandywine Plan, an attempt organize local people for the per- anent protection of the environ- ental amenities of their own land.

The Upper East Branch of randywine Creek drains a rolling isin of farms, fields, woodlands, id a sprinkling of residential eas. Because it lies at the far edge the commuting range to the pop- ation centers of Philadelphia and ilmington, the basin's natural auty has barely been touched by e blight of suburban sprawl. The aters of its streams are clear; its nple woodlands and fields are led with wildlife. Driving slowly rough the basin's winding roads id across its narrow bridges evokes e feeling of a pastoral painting, the ideal landscape of rural east- n America.

For two years, I had the privilege working closely with a group pre- iring a land plan for the Brandy- ine area. The plan was designed offer the inhabitants of the basin feasible way to preserve forever e natural qualities of their region om the inevitable wave of urban- ation. A report in *Science* maga- ne called it the perfect plan that iled.

My connection with the Brandy- ine Plan began one day in 1965 hen three people came into my of- ce in Washington. I had not previously known them, but their subsequent influence on my views about living in this world has been immense. Lawyer Ann Louise Strong, pretty and vivacious; Robert Coughlin, tall, taciturn, and practical; and Benjamin Stevens, dynamic idea man, wanted to talk about a project for which hydrologic help was necessary. They were affiliated with the Institute of Environmental Studies of the University of Pennsylvania and the Regional Science Research Institute.

Over the previous several years I had been attempting to organize a study project in which a combination of people—engineers, hydrologists, land planners, economists, and lawyers—might study the impact of urbanization on landscape in some local area. I had met with practically no success because, although I could muster the necessary talent in the engineering and hydrological fields. I could not find the right kind of people from the other disciplines. When my visitors explained that they had such a project well under way and now needed the infusion of engineering and hydrologic talent, I felt as if Dame Fortune had delivered them into my lap. "Your project has just acquired a hydrologist," I said.

They had not as yet picked the land area on which the experiment was to be tried, but they had worked out in some detail the things they believed the project might accomplish. The general idea was to choose a basin of small or moderate size and to draw up a land plan, hydrologically sound and legally possible, that would give assurance of the long-term maintenance of landscape amenities. The plan would be predicated on the idea that landowners within the basin, with the support and authority of their local elected officials, would take community action to achieve the desired results.

The plan would allow for population increase. but the location of developments would be guided. Through her legal and land-planning experience, Mrs. Strong had developed some innovative schemes that centered around the purchase of easements against uncontrolled development. Voluntary community action could lead to the design and testing of these new legal instruments. Hopefully, the plan would overcome some of the intrinsic and time-proved weaknesses of mere land zoning.

Under the plan. landowners in various parts of the basin would sell easements, thereby precluding any further development of those lands. Each landowner would not only be paid a fair price for the easement on development rights but, we reasoned, would also benefit because the land surrounding the undeveloped tracts would gain in value. In fact, we believed that the preservation of certain sites from

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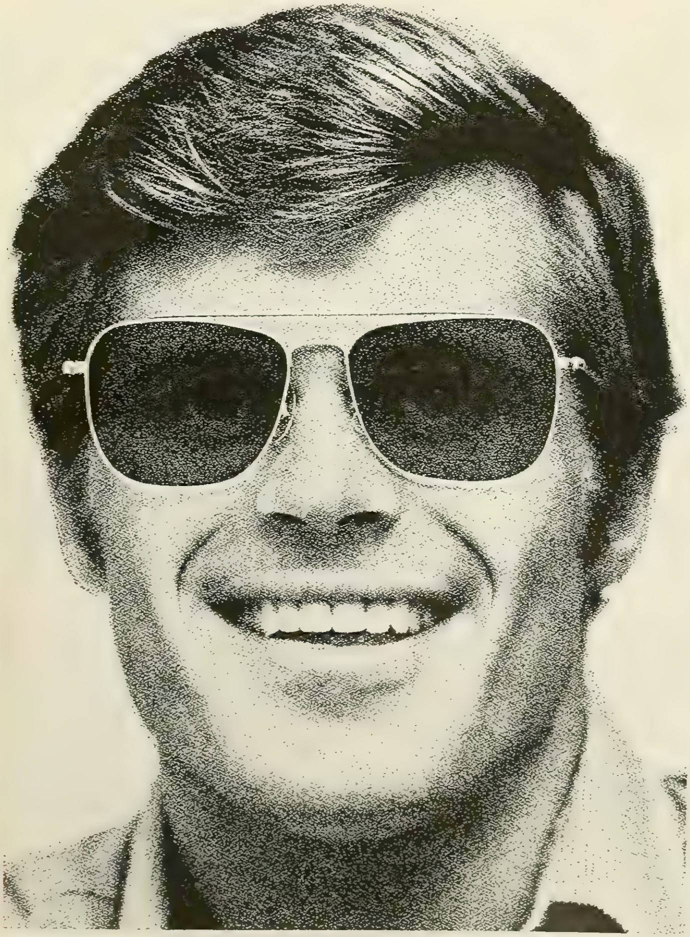

development would ultimately increase total property values so that tax revenues eventually would be greater for the region. However, such a scheme had never been tested.

This meant that we had to obtain financial support for the plan, including funds to buy the easements. And we had to convince the inhabitants that their participation in the plan would reap both esthetic and financial benefits to themselves. We believed the plan would prove itself in the long run, but we found to our regret that the success or failure of a plan depends on short-run events.

First came the selection of a river basin. We considered several sites and finally settled on the Upper East Branch of the Brandywine Creek for many reasons. The region had a heritage of watershed protection through the efforts of the Brandywine Valley Watershed Association. The leader of the association, Robert Struble, was also executive director of the Chester County Water Resources Authority, a state-authorized agency. The basin was sufficiently close to our technical headquarters at the University of Pennsylvania in Philadelphia and was of adequate size, but not too big. It covered 23.500 acres and was about 12 miles long and 3½ miles at its widest point. The area already was feeling the pressures of urbanization, yet it still remained agricultural, with only 3 percent of the land covered with homes, barns, streets, and driveways.

The upper part of Brandywine Creek watershed is located primarily in Chester County, Pennsylvania, but the mouth is at Wilmington, Delaware. The lower end of the basin is the site of some beautiful, large estates owned by executives of that industrial city. The upper part of the basin, farther from the centers of industry, is populated by middle-class landowners. We felt it would have been easier to persuade a group of landowners whose economic status afforded them the luxury of foregoing development of a portion of their land. However, as a pilot project applicable in principle to other areas, a watershed owned primarily by wealthy landowners would not be representative. We therefore chose the difficult job of

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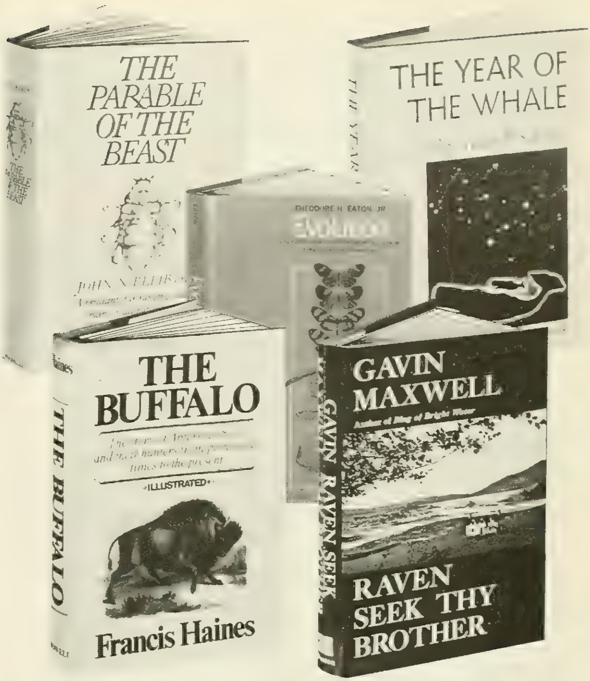

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persuading people of modest means to organize in their own behalf for purposes that would have to be only partially monetary. I still think that decision was right, although it was the underlying cause of many of our impending difficulties.

One of the principal constraints in the development of the land plan was the legal authority under which it would be possible to buy easements. Over a period of time Strong and her associates had assisted in the preparation of legislation that, if passed by the Pennsylvania legislature, would clarify and extend the powers of the state and counties to act for resource protection. But for the present, the main legal basis for the plan was a forward-looking but somewhat restrictive Pennsylvania law that permitted a county to form a water resources authority with certain legal powers. Among these powers was the right of eminent domain for the protection of the water resources of that county. This law gave protection of the water resources as the only justification for the exercise of the legal rights. The law did not include protection of other environmental features, such as natural beauty, open space, and recreation. Under this legislation, therefore, we had to devise a plan whose net result would be justified by its protective effect on the quantity and quality of the water.

Next came the financing of the project. Since the easement concept had never been tried, we felt we needed major financial support to implement the Brandywine Plan. Toward this end, Strong, Coughlin, Stevens, and John Keene, a lawyer-planner who was on the team, had been negotiating for some time with the Ford Foundation even before they had approached me for help in hydrologic work.

I remember well my first meeting, in the fall of 1965, with Gordon Harrison of the Ford Foundation when we called on him at his New York office. We realized that we were talking about an experiment, indeed, a far-out one. There were many possibilities of failure. We did not know whether the basic Pennsylvania legislation was sufficient for our purposes. We had no idea whether the residents of the Upper East Branch would be

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nterested. We did not know /hether the county commissioners ould be persuaded to let us make a ry. We did not know how much the tudy would cost or exactly what he technical problems were of comiling maps of soils, woodlands, land lopes, and land ownership.

Harrison was patient and understanding, but he was trying to make n honest assessment of whether the roject's likelihood of success was ufficient to justify the Ford Founation's financial help. There was a ot of money involved. To do the lanning and associated studies luring a period of a year and a ialf could cost several hundred housand dollars. If the landowners ccepted the plan, we were asking he Ford Foundation for a comnitment to provide at least a porion of the cash needed to purchase and easements. We argued that if ve had a firm guarantee that the oundation would provide half of he money necessary for the purhase of the easements, the possiility of interesting the federal govrnment in providing the other half vould be enhanced.

To his credit, Harrison agreed hat the project was worthwhile. He tated that he would recommend to iis board the approval of an imortant part of the money we reuested. Further, if they agreed to inance the project through the ighteen-month planning stage, the inancing would be accompanied by gentleman's understanding that he Ford Foundation would furnish ome support for the purchase of asements. So far, so good.

Next came technical problems of type none of us had ever faced efore. To my discomfiture, it beame clear that the designation of he lands to be protected against deelopment would have to be based n hydrologic principles alone beause it was only for the protection f water resources that the state law llowed a county water resources uthority to exert legal jurisdiction.

To protect the water resources of small basin from degradation—ither by pollution, increased flooding, or erosion—what parts of the asin would be the most important o protect and what should be the ature of the protection? Research esults give some hints of possible nswers, but there is an amazingly

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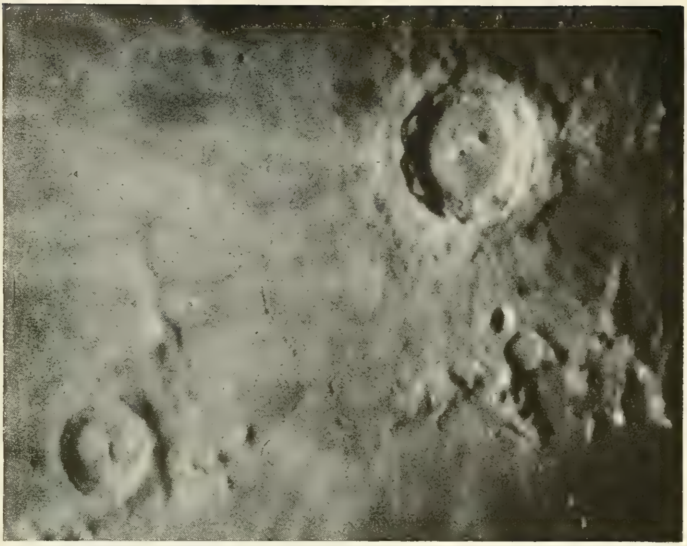

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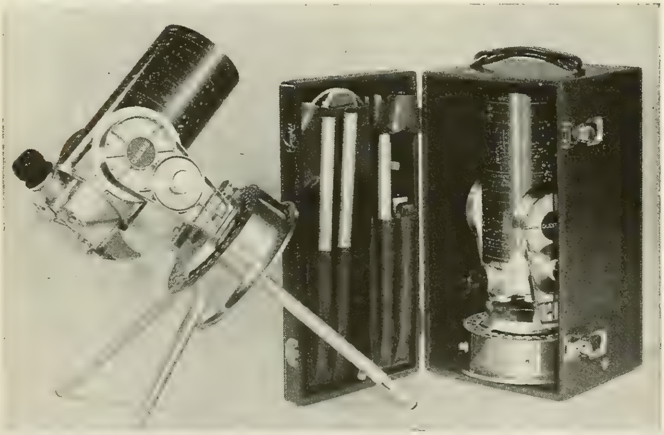

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small amount of quantitative information available on the effects of urbanization on the hydrologic functioning of stream basins. A flood plain is that part of a river valley where water spreads out during heavy storms and floods. The river constructs its channel only large enough to take the highest flow of water of every year or every other year. Discharges in excess of this spread widely over the valley flat, a mechanism that decreases flood peaks as a flood control reservoir would. Long experience has shown that when people build on the flood plain, they are asking for trouble. When structures border the channel itself, flood damage is assured. This knowledge and experience made it evident that there must be restrictions against permanent buildings on the flood plain.

The Brandywine Basin, like many similar agricultural drainages in eastern United States, has no central water supply system and no sewage disposal plants. Because the houses are dispersed, each must have an individual septic system, which moves sewage from a tank into tile drains from which the effluent infiltrates the soil. In a satisfactorily operating septic tank system, where most of the organic materials are broken down by bacterial action in the tank, effluents in the drain fields are screened of bacteria within a distance of 100 feet in permeable soils. We reasoned, therefore, that all structures should be set back from even the minor stream channels by at least 100 feet. Furthermore, soil eroded from construction sites within 100 feet of a small, usually dry channel will find its way into the channel and move into the river system. To protect the river system against erosion products from construction and other activities, it was felt that a 100-foot setback from minor channels was not sufficient and 300 feet would be preferable.

Steep slopes produce more rapid runoff and are more susceptible to soil erosion. The maximum slope on which construction should be allowed was another point not clearly shown by research data. We believed that slopes steeper than 15 percent gradient (a 15-foot fall per 100 feet of distance) should be protected from encroachment.

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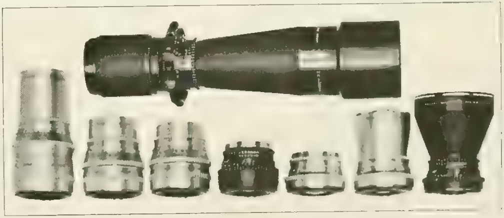
The Hasselblad also lets you hoot from positions where you ouldn't or wouldn't want to be ourself. You can shoot with the camera on the ground, without having to lie down beside it (an advantage if you're shooting near a giant ant hill). You can even shoot above hedges or crowds by viewing with the camera held upside down, overhead.

If you really want to put distance between yourself and the camera, the electrically-driven Hasselblad can be operated from a mile and a half away. By remote radio control.

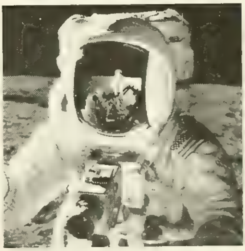
A good camera should let you see your results without the need of enlarging equipment. The Hasselblad takes big 2¼" square pictures, which you can see clearly with your naked eye.

A good travelling camera should have good lenses, in a variety of focal lengths. The Hasselblad System includes ten interchangeable Carl Zeiss lenses. The widest covers a sweep of 88°. The longest narrows down your field to 9°, to shoot details or to bring far away objects closer.



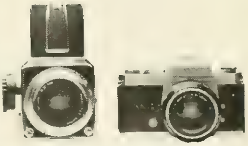
A good portable camera should be able to be used with portable lighting equipment, such as electronic flash, at all speeds. Which means it shouldn't have a focal plane shutter. Hasselblad has Compur shutters in all lenses, which can be synchronized with electronic flash at all speeds up to 1/500 second.

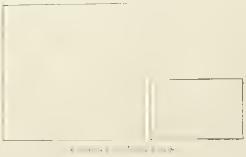
A good camera should be able to follow you to the ends of the earth without complaining. Hasselblads have performed everywhere from deep in the sea to the airless surface of the moon. (Hasselblads have been used on every manned space flight since 1962.)



A good camera should let you take good pictures even when there isn't time to focus properly (for instance when you're being chased by a creature bigger than yourself). With the Hasselblad Super Wide C you can shoot while running. Everything will be sharp from 12" to infinity.

And of course the camera you take with you should be comfortable to carry. When you sling a Hasselblad over your shoulder lens down, it doesn't feel much different than a 35mm camera. Yet the 2¼" x 2¼" images it produces are more than three times larger than the 35mm image.





So while we couldn't in good conscience describe the Hasselblad as a miniature camera, it's actually the smallest camera in the world that can do all the things it does.

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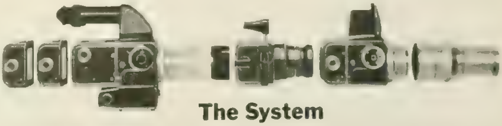

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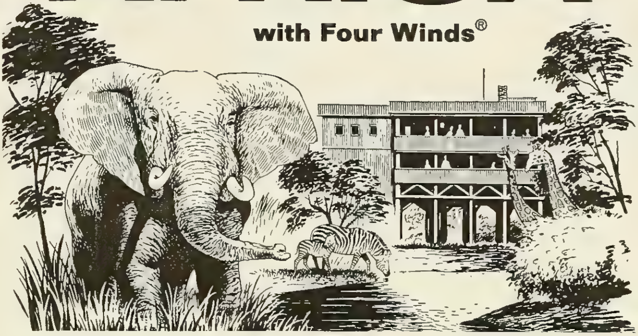

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When the areas chosen for restriction were plotted on a map, the result was close to our intuitive estimate that about 50 percent of the total drainage basin would have to be protected from housing and other development if the hydrologic functioning was to be preserved. This protected area would be a fan-shaped interfingering of open green space, coincident with the channel network following each valley nearly to its headwaters. The unprotected area where housing and other development would be concentrated would be the uplands. From there, houses and factories would have a vista downhill into a mixture of woods and fields so that nearly everybody on the upland would be only a short distance from some portion of the protected green space. There would be another advantage to this type of distribution of housing and industry: it would lead to cluster development rather than the less interesting pattern of one house right after another in boring uniformity.

To maintain this kind of land pattern as the population continued to increase, lands would be protected by the sale of an easement to the County Water Resources Authority. The easement would be a legal contract, permanently and irrevocably attached to the property deed. The landowner would, under the terms of the easement, be able to continue whatever land use was presently on the property, but he would forfeit the right to construct new buildings, put in a housing development, or construct a factory. Each property owner, however, would have the right to build one house for his own use.

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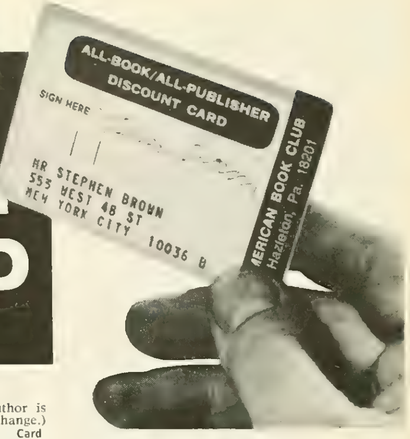

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which, because of the plan, would be far more likely to be used for housing or industrial development. In addition, the Brandywine Plan proposed long-range studies of regional water supply and sewerage installations located with regard to environmental protection as well as to engineering feasibility.

When the legal and technical details were worked out, the hard work began—the job of convincing the people. I live in Washington, whereas Strong, Coughlin, Stevens, and Keene live near Philadelphia. One can hardly imagine the number of meetings that were required. First, it was necessary to convince the elected county commissioners of Chester County. We wanted to persuade them to let us make a try with the understanding that if the local people accepted the plan, the county commissioners would give it the weight of their authority in carrying out the implied legal obligations. Then it was necessary to convince the recently created Water Resources Authority of Chester County, a body hardly in a position to be looking for new legal tests of its authority. We needed the support of the County Planning Commission. There were evening meetings in schoolhouses and firehouses, in churches, and in community halls.

We got the go-ahead from the county commissioners provided we could persuade the elected supervisors from nine townships. That meant convincing not fewer than eleven administrative entities and many more individuals. It took many meetings with each group, and in all of these meetings, the people donated their time to hear us out.

Amazingly, we persuaded the county commissioners and the Water Resources Authority, as well as the elected representatives of all the townships, to allow us to proceed with developing the plan. It was understood that the plan would be a document that could be presented to the constituencies of each of these bodies for some sort of referendum. Although I attended many of the meetings, the time I spent was small compared with that spent by my associates. All I can say is that the job of convincing people, persuading people, and telling people was unbelievably time consuming. How my colleagues kept peace in their respective families during these trying times, I don't know, because the number of evenings away from home, traveling to some distant schoolhouse, were practically beyond count.

I remember a meeting in a schoolhouse one snowy evening in 1966. My presentation concerned the characteristics of flood plains and why such areas should not be used for building houses. We tried to elicit questions but the small audience, mostly farmers and business people, although attentive, was not inclined to speak out. Even when the formal presentations were over, it was not easy to engage the landowners in conversation. I always had the feeling we were not quite reaching them—maybe we were not explaining ourselves in their terms. In the early stages it was impossible to tell each owner how the plan would affect his particular land.

A few began a vigorous and vocal campaign to defeat the plan, even while it was still being constructed. In October, 1967, opponents formed the Chester County Freeholders' Association, which garnered a membership of about 50 of the 1,400 families that owned land in the basin.

A typical "letter to the editor" from these opponents appeared in the *Local News* of West Chester on February 17, 1968:

"We believe that time-honored private property rights and management of private lands are a basic keystone in a capitalistic democracy. We believe that when a state agency attempts to restrict these rights for eternity in from 50 percent to 60 percent of the land areas of whole townships, we are approaching a decision which will affect our heritage and future as free citizens. . . .

"This program is not conservation, it is conscription. It is not in the public welfare. Projects such as these are dangerous, not only because of the loss of the individual's rights but because they may well lay government open to vastly increased opportunity for venality in conjunction with builders and developers, who naturally will flock to influence just which land areas will be restricted and which adjacent land will rise enormously in value because of the artificially created scarcity of building ground.

"We hope that you, Mr. Weaver [Secretary of Housing and Urban Development], will see through this thinly veiled power grab. That you will learn just who will benefit from this loss of citizens rights, and that you will protect us against the first thrust of a forcible seizure of civil rights, which if allowed will create a precedent undermining the very bedrock philosophy of our Democracy."

Many factors contributed to the ultimate failure, which came in the form of voted disapproval by several townships even before the final plan was printed. The disapprovals snowballed. Where had we failed?

One of our greatest bungles was the attempt to persuade the landowners to agree to the use of eminent domain to obtain easements from the presumably small proportion of owners who would refuse to sell an easement. The inhabitants of the basin had experienced bitter battles with utility companies and other bodies who had used eminent domain to obtain easements for pipelines, a 500-kilowatt powerline, and a reservoir. They had had enough of eminent domain, regardless of the purposes. We realized this too late, and by the time the staff backed off from eminent domain and accepted the idea of voluntary sale of easements, the public reaction against any plan had built up beyond reversal.

But perhaps the greatest mistake lay in our failure to organize leaders among the landowners as principal spokesmen for the plan. We relied too much on the project staff to give the explanations and to answer questions. So it appeared to the landowners that the plan was something concocted by outsiders to be pressed upon them, rather than merely a proposal aimed at accomplishing what they, the landowners, wanted for themselves. Though we had support from many owners who could see the need for such land planning to protect their own interests, these friends of the effort were never organized to be the principal leaders in public discussion. Whether we could have spurred local leadership to organize, it is impossible to say.

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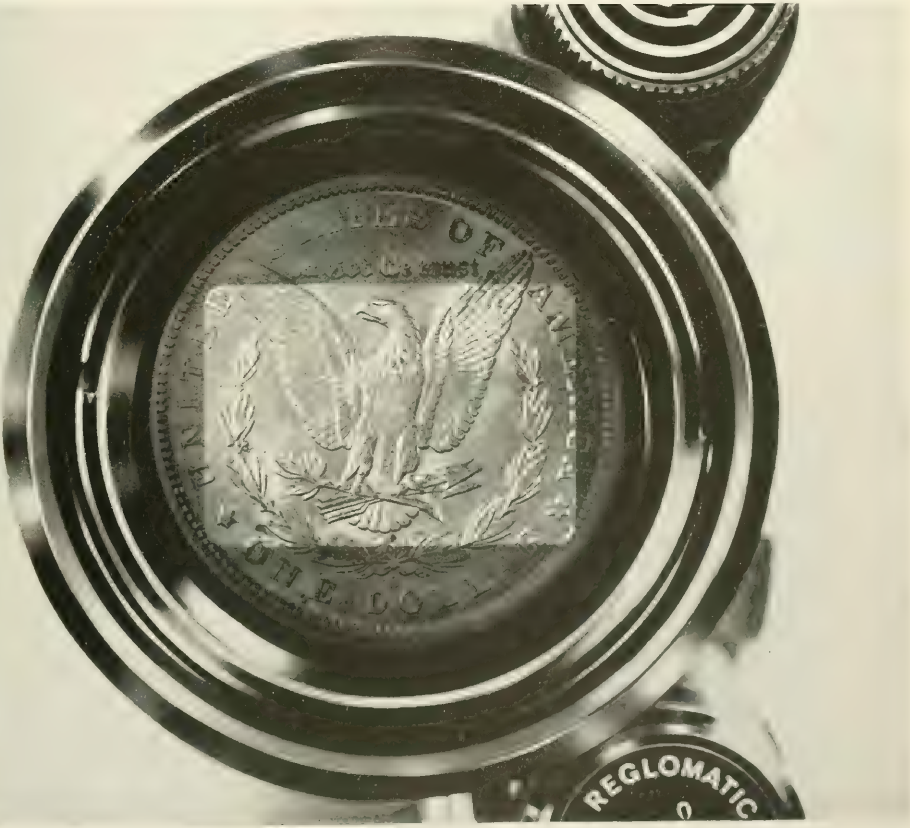

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luck in the process of obtaining independent appraisal of the monetary value of the easements. The staff hired an experienced land appraiser, and he used two local appraisers, but his work started late. Further, his appraised values were less specific than we needed and did not cover the variety of combinations of acreage, location, land type, and land use that existed. As a result, when owners first asked how much they could expect from the sale of a particular easement, we were unable to give any answer. And at the end the answers were too unspecific to satisfy the potential seller. Also we experienced what other planners have seen: that the seller of an easement often jacks his price up to an amount equal to, or perhaps greater than, the present sale value of the land itself. Some owners, therefore, felt that the staff was, in the early stages, being devious about the monetary value of an easement when, in fact, we were trying desperately to obtain specific appraisals. And when appraisals became available, some owners felt that the easement was worth more than the appraised value.

An interesting aspect of the failure of the plan was apprehension. The landowners had several fears, some quite understandable, others irrational but nevertheless influential. They were worried by the possibility that if an easement were sold, they could not get a mortgage. Although local bankers disclaimed the possibility in private, absence of clear public statements allowed the apprehension to persist.

Residents had an understandable fear of legal entanglement. They also were concerned about whether the protected land in woods and flood plain would be open game for location of highways, pipelines, electric lines, and other utilities. There was a pervasive fear of government—that government was impersonal, unresponsive to local needs and desires, and corruptible. There was concern that at some future time the Chester County Water Resources Authority, who would own the easements, would use them in some unforeseen way to the detriment of landowners.

We conducted an attitude survey of owners in the basin to determine how important landscape beauty and amenities were to the local population. A surprisingly large proportion, 83 percent of those interviewed, expressed themselves as being concerned with their natural environment. But this expressed attitude was apparently outweighed by natural cupidity, for a large number of owners harbored the idea that if urbanization did spread into the basin, they would make a killing by sale of property to some developer. There were many people, on the other hand, who believed that the basin would not change, that urbanization was far away and would not strike their watershed. The actual record of land sales and growth on the immediate edges of the basin and along the main highways in the basin did not dispel this complacency.

Finally, the plan rested on too weak a legal base. If the protection of the landscape—the whole environment—has meaning, then basic legislation should spell out not merely the water resources, but also amenities of a nonmonetary and esthetic type as societal values to be given some legal protection.

In the three years since the Brandywine Plan was voted down, great impetus has been given to the imperative need for environmental protection as a necessary ingredient in maintaining the quality of life. But even if the surge of public interest had begun earlier, the detailed problems faced by any new scheme for achieving rational land planning would have been the same. There is no substitute for local leadership in community action, in the collection and dissemination of relevant facts, and in grassroots organization. These take time. The terms of the financing for our planning effort did not permit us to take the time that, hindsight says, was required.

The protection of the environment is a lofty goal. Necessary as it seems in principle, it is in many respects diffuse and elusive. A society attains it indirectly by action or inaction on common and mundane matters, heavily influenced by custom, by monetary considerations, and by political forces. Experience on the Brandywine is a clear signal that the road to such a goal is long, steep, and rocky.

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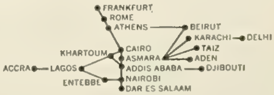

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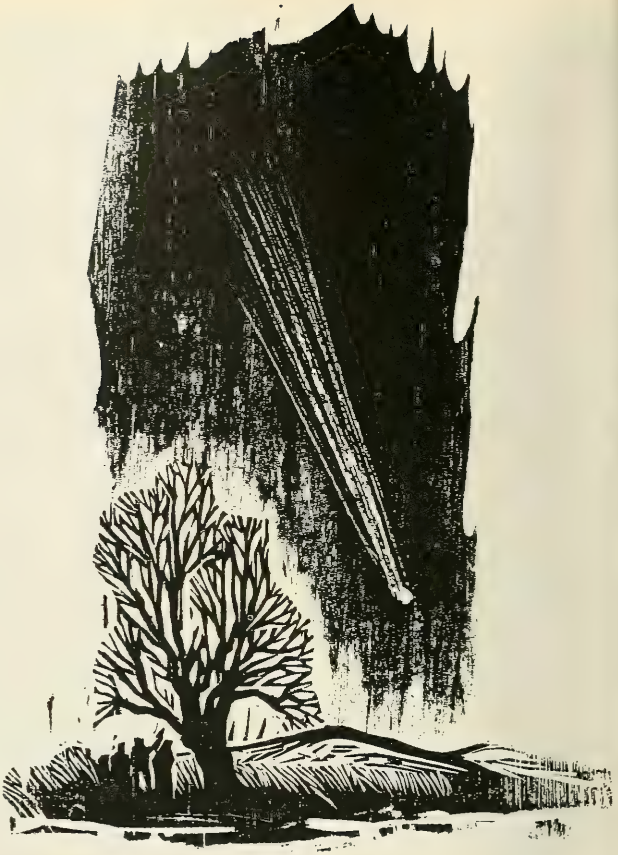

The Star Dragon

Evolution became history when man developed a specialized organ—the brain—whose essential purpose was to avoid specialization

by Loren Eiseley

In the year 1910 Halley's comet—the comet that had flared in 1066 over the Norman invasion of England—was again after many visitations brightening the night skies of earth. "Menace of the Skies," shrieked the more lurid newspapers.

Like hundreds of other little boys of the new century, I was held up in my father's arms under the cottonwoods of a cold and leafless spring to see the hurtling emissary of the void. My father told me something then that is one of my earliest and most cherished memories.

"If you live to be an old man," he said carefully, fixing my eyes on the midnight spectacle, "you will see it again. It will come back in seventy-five years. Remember," he whispered in my ear, "I will be gone, but you will see it. All that time it will be traveling in the dark, but somewhere, far out there . . ." he swept a hand toward the blue horizon of the Plains, "it will turn back. It is running glittering through millions of miles."

I tightened my hold on my father's neck and stared uncomprehendingly at the heavens. Once more he spoke against my ear and for us two alone. "Remember, all you have to do is to be careful and wait. You will be seventy-eight or seventy-nine years old. I think you will live to see it—for me," he whispered a little sadly, with the foreknowledge that was part of his nature.

"Yes, Papa," I said dutifully, having little or no grasp of seventy-five years or millions of miles on the floorless pathways of space. Nevertheless, I was destined to remember the incident all my life. It was out of love for a sad man who clung to me as I to him, that, young though I was, I remembered. There are sixteen years still to pass, and already I am breathing like a tired runner, but the voice still sounds in my ears and I know with the sureness of maturity that the great wild satellite has reversed its course and is speeding on its homeward journey toward the sun.

At four I had been fixed with the compulsive vertigo of vast distance and even more endless time. I had received, through inherited temperament and inclination, a nostalgic admonition to tarry. Besides, I had given what amounted to a desperate promise. "Yes, Papa," I had said with the generosity of childhood, not knowing the chances that men faced in life. A month ago, af-

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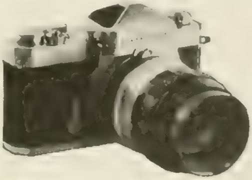

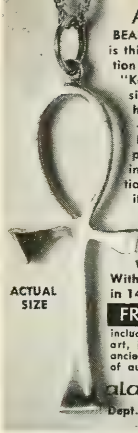

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ter a visit to my doctor, I had written anxiously to an astronomer friend. "Brad," I had asked, "where is Halley's comet reported on the homeward track? I know it must have turned the elliptic, but where do you calculate it now, how far—and how long, how long?"

I have his answer before me. "You're pushing things, old man," he writes. "Don't expect us to see it yet—you're too young. The orbit is roughly eighteen astronomical units or one billion six hundred and fifty miles. It headed back this way probably in 1948."

1948. I grope wearily amidst memories of the cold war, Korea, the Berlin blockade, spies, the impossible-to-be-kept secrets of the atom. All that time through the black void, the tiny pinpoint of light has been hurrying, hurrying, running faster than I, thousands of miles faster as it curves toward home. Because of my father and the promise I had made, a kind of personal bond has been projected between me and the comet. I do not think of what it heralded over Hastings in 1066. I think it is racing sunward so that I can see it stretched once more across the heavens, and momently restore the innocence of 1910.

But there is inner time, "personal, private chronometry," a brain surgeon once told me. There is also outer time that harries us ruthlessly to our deaths. Some nights in a dark room, staring at the ceiling, I can see the light like a mote in my eye, like a far-off train headlight glimpsed long ago as a child on the prairies of the West. The mournful howl of a train whistle echoes in my head and mingles with the night's black spaces. The voice is that of the comet as I hear it, climbing upward on the arc of space. At last in the dark I compose myself for sleep. I pull the blanket up to my chin and think of radar ceaselessly sweeping the horizon, and the intercontinental missiles resting in their blast-hardened pits.

But no, I dream deeper, slipping back like a sorcerer through the wood of time. Life was no better, not even as safe, proportionately, in the neolithic hill forts whose tiny trenches can be seen from the air over the British downs. A little band of men, with their families beside them, crouched sleepless with ill-made swords, awaiting an attack at dawn. And before that, the caves and the freezing cold, with the ice creeping ever southward autumn by autumn.

The dead we buried in red ochre under the fire pit, the red standing for blood, for we were quick in analogies and magic. The ochre was for life elsewhere and farewell. We tramped away in our furred garb and the leaves and snow washed over the place of our youth. We worked always toward the south across the tundra, following the long trail of the mammoth. Someone saw a vast flame in the sky and pointed, but it was not called Halley's comet then. You could see it glinting through the green light and the falling snow.

Farther backward still, across twin ice advances and two long interglacial summers. We were cruder now, our eyes wild and uncertain, less sure that we were men. We no longer had sewn garments, and our only weapon was a heavy, pointed stone, unhafted and held in the hand. Even our faces had taken on the cavernous look of the places we

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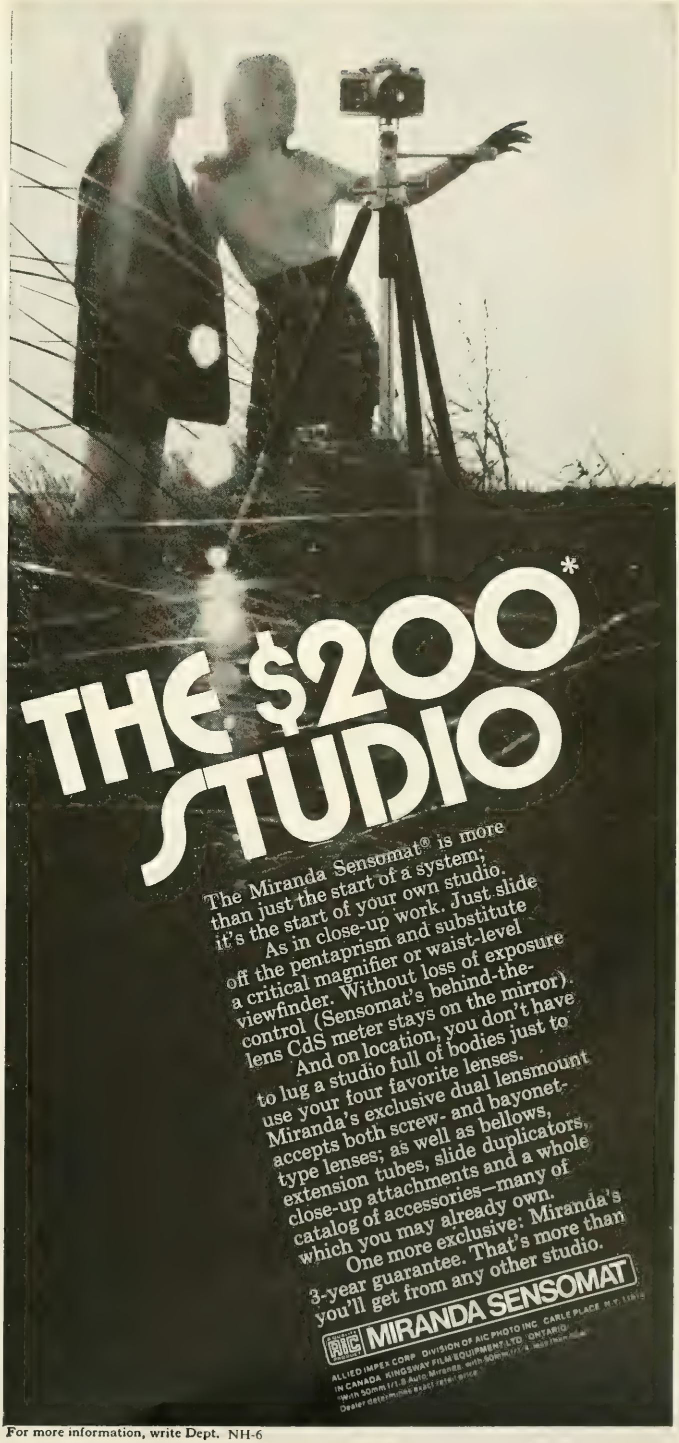
inhabited. There were difficulties about making fire, and we could not always achieve it. The dead were left where they fell. Women wept less and the bands were smaller. Our memories consisted of dim lights under heavy sockets of bone. We did not paint pictures or increase, by magic, the slain beasts. We talked, but the words we needed were fewer. Often we went hungry. It was a sturdy child that survived. We meant well, but we were terrifyingly ignorant and given to frustrated anger. There was too much locked up in us that we could not express.

We were being used, and perhaps it was against this that we unconsciously raged the most. We were neither beast nor man. We were only a bridge transmitting life. I say we were almost animals and knew little, but this we felt and raged against. There were no words to help us. No one could think of them. Sometimes we were stalked by the huge cats, but it was the inner stalking that was most terrible. I saw a star in the sky with a flaming tail and cowered, shaking, into a bush, making uncouth sounds. It is not laughable. Animals do not do this. They do not see the world as we do—even we.

I think we are now well across the last ice, toward the beginning. There is no fire of any sort but we do not miss it. We are far to the south and the climate is warm. We have no tools except an occasional bone club. We walk upright but I think we are now animals. We are small—pygmies, in fact. We wear no clothes. We no longer stare at the stars or think of the unreal. The dead are dead. No one follows us at nightfall. Do not repeat this. I think we are animals. I think we have reached the bridge. We are happy here. Tell no one.

I sigh in my sleep but I cannot hold to the other side of the bridge—the animal side. The comet turns blazing on its far run into space. Slowly I plod once more with the furred ones up the ladder of time. We cross one ice and then another. There is much weeping, too much of memory. It is all to do over again and go on. The white-robed men think well in Athens. I heard a man named Pindar acclaim something that implied we have a



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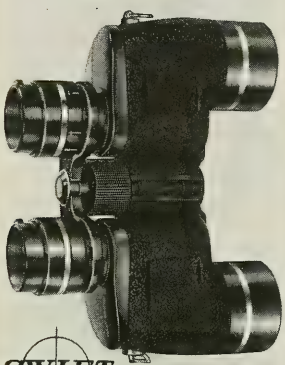

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likeness to the immortals. "What course after nightfall," he questioned, "has destiny written that we must run to the end?"

What course after nightfall? I have followed the comet's track returning and returning while our minds and our bodies changed. The comet will appear once more. I will follow it that far. Then I will no longer be part of the bridge. Perhaps I will be released to go back. Time and space are my inheritance from my father and the star. I will climb no further up the ladder of fiery return. I will go forward only one more rung. What will await me there is not pleasant but it is in the star's destiny as well as mine. I lie awake once more on the dark bed. I feel my heart beating, and wait for the hurrying light.

In 1804, just one hundred and sixty-six years ago, Capt. William Clark recorded in his diary far up the unknown Missouri that ahead of the little expedition that he shared with Meriwether Lewis hung a formidable curtain of blowing dust through which they could not see.

"Tell us what is new," the few savants in the newborn American republic had advised the explorers when they departed westward. Men continued to have strange expectations of what lay hidden in the still uncharted wilds behind the screen of the great eastern forest. Some thought the mammoth, whose bones had been found at Big Bone Lick, in Kentucky, might still wander alive and trumpeting in that vast hinterland. The "dreadful curtain" through which the youthful captains peered on that cold, forbidding day in January could have hidden anything. Indeed the cloud itself was symbolic. It represented time in inconceivable quantities—time, not safe, not contained in Christian quantity, but rather, vast as the elemental dust storm itself.

The dust in those remote regions was the dust of ice ages, of mountains wearing away under the splintering of frost and sun. The Platte was slowly carrying a mountain range to the sea over giant fans of gravel. Fremont's men would later report the strange and grotesque sculptures of the wind in stone. It was true that a few years earlier the Scottish physician James Hutton had philosophically conceived such eons of time as possible. His views had largely proved unwelcome and had been dismissed in Europe. On the far-western divide, however, amid the roar of waters falling toward an unknown westward ocean, men, frontiersmen though they were, must have felt with an increasing tinge of awe the weight of ages unknown to man.

Huge bones bulked in the exposed strata and were measured with wonder. No man knew their names or their antiquity. New things the savants had sought surrounded the explorers, not in the sense of the living survival of great elephants, but rather in the sense of a vaster novelty—the extension of time itself. It was as though man for the first time was intruding upon some gigantic stage not devised for him. Among these wastes one felt as though inhuman actors had departed, as though the drama of life had reached an unexpected climax.

It is perhaps a significant coincidence that man's full recognition of biological novelty, of the invisible transformations of the living substance itself, came close upon the heels of the discovery of the vast wilderness stage which still held the tumbled bones of the former actors. It was a domain that had remained largely unknown to Europeans. Sir Charles Lyell, who, in the 1830's, successfully revived Hutton's lost doctrines of geological antiquity, visited the United States in the 1840's and lectured to enthralled thousands. Finally, it was Charles Darwin, the voyager-naturalist, who, as a convinced follower of Lyell, had gazed upon a comparable wilderness in South America and had succeeded, in his mind's eye, in peopling the abandoned stage with the creatures of former epochs. It was almost as though Europe, though rife with speculation since the time of the great voyagers, could not quite escape its man-centeredness or its preoccupation with civilized hedgerows and formal gardens. Its thinkers had still to breathe, like Darwin, the thin air of Andean highlands, or hear the falling of

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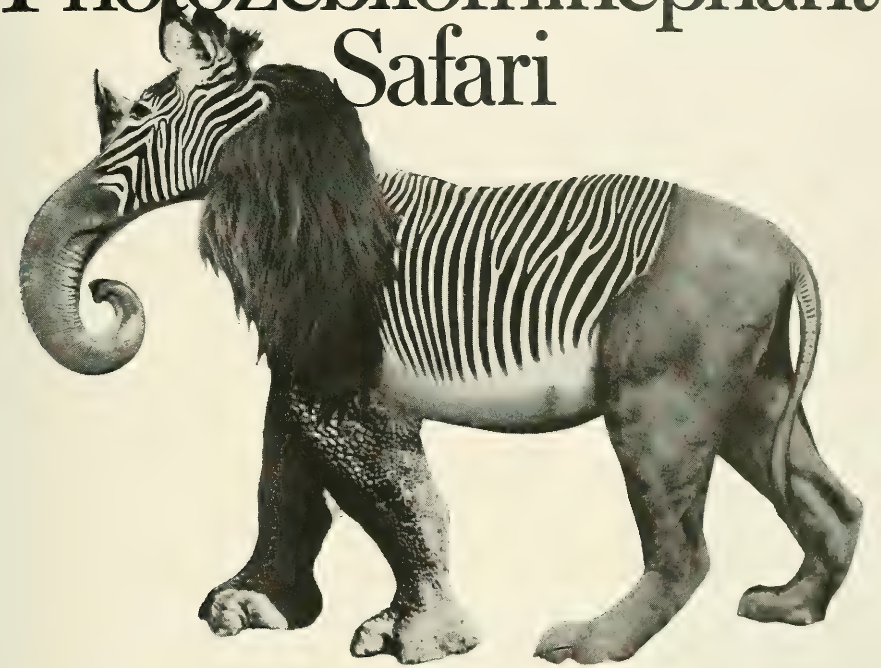

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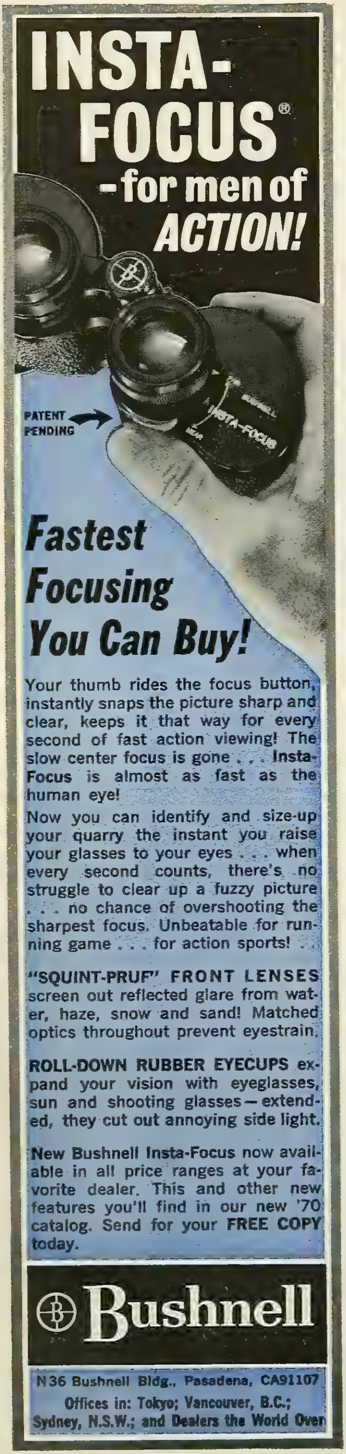
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stones in mountain cataracts.

To see his role on the world stage, Western man had twice to revise his conception of time: once from the brevity of a few thousand years to eons of inconceivable antiquity and, a second time, with far more difficulty, to perceive that this lengthened time-span was peopled with wraiths and changing cloud forms. Time was not just aged rocks and trees, alike since the beginning of creation; its living aspect did not consist merely of endless Oriental cycles of civilizations rising and declining. Instead, the living flesh itself was alterable. Our seeming stability of form was an illusion fostered by the few millennia of written history. Behind that history lay the vast and unrecorded gloom of ice ages inhabited by the great beasts, which the explorers, at Thomas Jefferson's bidding, had sought through the blowing curtain of the dust.

Man, but not man in the garb we know, had cracked marrow bones in those dim shadows before his footprints vanished amidst the grass of wild savannas. For interminable ages winged reptiles had hovered over the shores of ancient seas; creatures still more strange had paddled in the silence of enormous swamps. Finally, in that long backward range of time, it was possible to emerge upon shores that no longer betrayed signs of life, because life had become mere potential.

At that point one could have seen life as the novelty it truly is. "Tell us all that is new," the eager scientists had said to the explorers. Now, past midcentury, an answer could be made. It was life itself that was eternally, constantly new. Dust settled and blew the same from age to age; mountains were worn down to rise again. Only life, that furtive intruder drifting across marsh and field and mountain, altered its masks upon the age-old stage. And as the masks were discarded they did not come again as did the lava of the upthrust mountain cores. Species died as individuals died, or if they did not perish, they were altered beyond recognition and recall. Man cannot restore the body that once shaped his mind. The bird upon the bough cannot, any more than a summer's yellow butterfly, again materialize the chrysalis from which it sprang.

Indeed, in the end, life can be seen not only as a novelty moving through time toward an endlessly diverging series of possible futures but also as a complete phantom. If we had only the scattered chemicals of the cast-off forms and no experience in ourselves of life's existence, we would not be able to identify its reality or its mutability by any chemical test known to us. The only thing that infuses a handful of dust with such uncanny potential is our empirical knowledge that the phenomenon called life exists, and that it constantly pursues an unseen arrow which is irreversible.

Through the anatomical effort and puzzle-fitting of many men, time, by the mid-nineteenth century, had become gigantic. When *The Origin of Species* was published, the great stage was seen not alone to have been playing to remote, forgotten audiences; the actors themselves still went masked into a future no man could anticipate. Some straggled out and died in the wings. But still the play persisted. As one watched, one could see that the play had one very strange quality about it: the characters, most of them, began in a kind of generous latitude of living space and ended by being pinched out of existence in a grimy corner.

Once in a while, it is true, a prisoner escaped just when all seemed over for him. It happened when some oxygen-starved Devonian fish managed to stump ashore on their fins and become the first vertebrate invaders of the land. By and large, however, the evolutionary story had a certain unhappy quality.

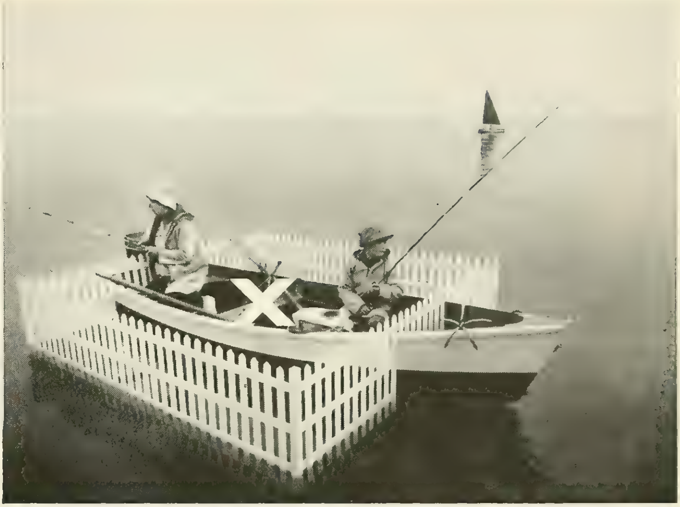
The evolutionary hero became a victim of his success and then could not turn backward; he prospered and grew too large and was set upon by clever enemies evolving about him. Or he specialized in diet, and the plants upon which he fed became increasingly rare. Or he survived at the cost of shutting out the light and eating his way into living rock, like some mollusks. Or he hid in deserts and survived through rarity and supersensitive ears. In cold climates he reduced his temperature with the season, dulled his heart to long-drawn spasmodic effort, and slept most of his life away. Or, parasitically, he slumbered in the warm intestinal darkness of the tapeworm's eyeless world.

Restricted and dark were many of these niches, and equally dark and malignant were some of the survivors. The oblique corner with no outlet had narrowed upon them all. Biological evolution could be defined as one long series of specializations—hoofs that prevented hands, wings that, while opening the wide reaches of the air, prevented the manipulation of tools. The list was endless. Each creature was a tiny fraction of the life force; the greater portion had died with the environments that created them. Others had continued to evolve, but always their transformations seemed to present a more skilled adaptation to an increasingly narrow corridor of existence. Success too frequently meant specialization, and specialization, ironically, was the beginning of the road to extinction. It was the essential theme that time had dramatized upon the giant stage.

It may now appear that I have been wandering mentally amidst irrelevant and strange events—time glimpsed through a blowing curtain of dust and, among fallen stones and badland pinnacles, bones denoting not just the erosion of ages but the mysterious transformation of living bodies.

Man after man in the immediately post-Darwinian days would stare into his mirror at the bony contours of a skull that held some grinning secret beyond the simple fact of death. Anatomists at the dissecting table would turn up odd vestigial muscles and organs. Our bodies held outdated machinery as strange as that to be found in the attics of old houses. Into these anatomical depths few would care to probe. But there were scholars who were not averse to delving among fossils, and the skulls they found or diagnosed would multiply. These would be recognized at last for what they were, the dropped masks of the beginning of Nature's last great play—the play of man.

Strangely, it is a different play, though made partly of old in-



If you could shoot on both sides of this fence you could make better movies.

Sit down at X and we'll show you why.

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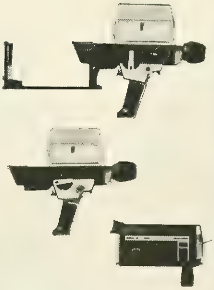
Stop fiddling with the knob. That shot's just 12 inches from your lens. You'll never get it in focus.

What about this? Nearly 3 ft. away? Nope. Still too blurry.

You'd have to walk on water to get far enough to shoot it with your conventional camera.

So what can you shoot? See that fence? It's 4 ft. from your seat, the closest most conventional cameras can focus. So you can get any shot—outside the fence. But nothing but blurs inside it.



Which brings us to these, the unconventional Bolex Macrozoom cameras. They're the first super-8s that can shoot on both sides of the fence. Because they can focus at least as near—or as far—as your eyes can.

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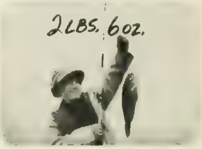
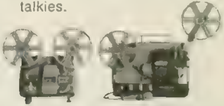
With these Bolex cameras you can get any shot you can see. Including telephoto shots like this one.

And if you snap on the free little Multitrix attachment, you can also title on location, like this.



Shoot stills. Shoot—and dissolve through—a slide. Make complete movies in the camera.

Want to see them for yourself? Write to the address below for the name of your nearest Bolex dealer. And, while you're there, see these unconventional Bolex projectors. One of them will even record a soundtrack onto your film, turning your silents into talkies.



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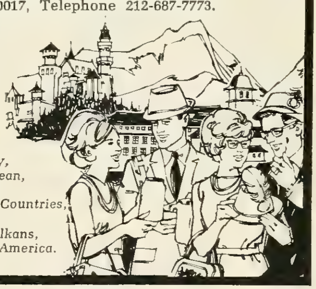

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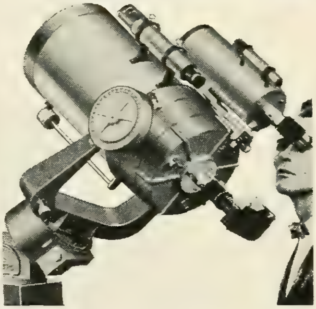

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gredients. In three billion years of life upon the planet, this play had never been acted upon the great stage before. We come at a unique moment in geological history, and we ourselves are equally unique. We have brought with us out of the forest darkness a new unprophesiable world—a latent, lurking universe within our heads.

In the world of Charles Darwin, evolution was particulate; it contained and traced the history of fins, claws, wings, and teeth. The Darwinian circle was immersed in the study of the response of the individual organism to its environment and the selective impact of the environment upon its creatures. By contrast, just as biological evolution had brought the magic of the endlessly new in organic form, so the evolving brain, through speech, had literally created a superorganic structure unimaginable until its emergence.

Alfred Russel Wallace, Darwin's contemporary, perceived that with the emergence of the human brain, man had, to a previously inconceivable degree, passed out of the domain of the particulate evolution of biological organs and had entered upon what we may call history. Human beings, in whom the power of communication had arisen, were leaving the realm of phylogeny for the realm of history, which was to contain, henceforth, our essential destiny. After three billion years of biological effort, man alone had seemingly evaded the oblique trap of biological specialization. He had done so by the development of a specialized organ—the brain—whose essential purpose was to evade specialization.

The tongue and the hand, so disproportionately exaggerated in our motor cortex, were to be its primary instruments. With these we would elude channelized instinct and channelized organic development. The creature who had dropped from some long-ago tree into the grass had managed to totter upright and free the grasping forelimb. Brain, hand, and tongue would henceforth evolve together. Fin, fur, and paw would vanish into the mists of the past. Henceforth it would be the brain that clothed and unclothed man. Fire would warm

continued on page 74

You and the Ecology Movement

Readers are urged to answer this questionnaire and mail it to NATURAL HISTORY for scientific analysis

Prepared by Luther P. Gerlach and Virginia Hine

Interest in ecology has moved from scholars to the public. Environmental Concern, the New Conservation, Ecology Activism, and Participatory Ecology are various names given to what appears to be a growing grass roots movement.

As anthropologists, we believe that this movement and its effects are so significant that it should be objectively studied and the consequent findings broadly disseminated. It is our belief that such information will contribute to adaptive change.

We began our study of the ecology movement in the summer of 1968, considering it as both significant in its own right and as one case study of a class of events we call "Movements of Personal Transformation and Social Change." Religious and sociopolitical movements constitute other cases of this class of events that we have studied. Our findings will be published this year in articles and a book, and are the subject of a film produced at the University of Minnesota. To obtain our data in these cases we used participant observations, interviews, media reviews, and questionnaires. Results from the following questionnaire will complement our other findings. We will analyze the returns in a fall issue of NATURAL HISTORY and relate the conclusions to our larger research.

We invite your assistance so that our results will most accurately reflect *your* personal experiences and opinions. We need your assistance.

Please answer the following questionnaire by filling in the answer box according to the instructions for each section. Mail your answers to:

NATURAL HISTORY Magazine
77 West 77th Street
The American Museum of Natural History
New York, New York 10024

INSTRUCTIONS

Please answer the first thirteen questions by putting in the answer box on the following page the number that describes your attitude, as follows:

(1) Strongly agree
(2) Agree
(3) Uncertain
(4) Disagree
(5) Strongly disagree

1. I believe that plants and animals exist primarily for man's use and enjoyment.

2. With advances in technology, I think that man will always be able to draw the resources he needs from the environment.

3. I think that pollution and racism are both part of the same basic problems in our society.

4. I do not think that I am personally responsible for our present state of pollution.

5. I am afraid that industrial and military plans to exploit the ocean's resources may seriously endanger human life on this planet.

6. I think that owners of private property should be free to use the plants and other natural resources on it pretty much as is now permitted by law and convention.

7. I believe that the profit motive in our society (desire for individual economic gain) is now outdated and must change.

8. I feel that our environmental problems probably cannot be solved by existing American political and economic institutions.

9. I think that *all* American families, regardless of social or economic position, must limit the number of children to two, or three at most.

10. I believe that our ecological crisis can be solved primarily by application of technology.

11. I feel that American beliefs and values have been a basic cause of our present environmental problems.

12. I believe that economic growth is nearly always good for any community.

13. I think that population control should be encouraged by removing tax exemptions for more than two children.

Please complete the rest of the questions by putting in each answer box the number of the statement (in parentheses) that best describes your opinion.

14. Do you feel that wild animals have any rights?

(1) Yes, equal to man's.
(2) Yes, but subordinate to man's.
(3) Undecided
(4) No

15. Have you ever been in a wilderness area beyond all roads and human habitation?

(1) Yes
(2) Uncertain
(3) No

16. If so, do you feel yourself to be different when you are in a wilderness area than when you are in a more man-made environment?

(1) Yes
(2) Undecided
(3) No

17. How do you see yourself in relation to the influential and powerful groups in your community?

(1) I am part of them and have

a voice in decision making.
- (2) I feel part of them even though I do not make decisions.
- (3) I am part of them but dislike it.
- (4) I am outside of them but not opposed to them.
- (5) I am outside of them and dislike them.
- (6) I am outside of them and actively oppose them.

18. How do you feel about the movement within the churches to increase active involvement in social problems?
- (1) Strongly agree
- (2) Agree
- (3) Uncertain
- (4) Disagree
- (5) Strongly disagree
- (6) I do not know enough about it to answer.

19. How do you feel about the movements within the church that stress personal religious experience (such as charismatic gifts, speaking in tongues, or other ecstatic experiences)?
- (1) Strongly agree
- (2) Agree
- (3) Uncertain
- (4) Disagree
- (5) Strongly disagree
- (6) I do not know enough about it to answer.

20. How do you feel about the peace movement (anti-Viet Nam war)?
- (1) I support it and am active in it.
- (2) I favor it generally but have not been active in it.
- (3) I am uncertain how I feel.
- (4) I agree with its goals but disapprove of its methods.
- (5) I disapprove of the movement but am against repressive action.
- (6) I disapprove and would like to see the movements suppressed.

21. How do you feel about the student movements in colleges?
- (1) I support them and am active in them.
- (2) I favor them generally but have not been active.
- (3) I am uncertain how I feel about them.
- (4) I agree with their goals but disapprove of their methods.
- (5) I disapprove of the movements but am against repressive action.
- (6) I disapprove and would like to see the movements suppressed.

22. How do you feel about the Black Power movement?
- (1) I support it and am active in it.
- (2) I favor it generally but have not been active.
- (3) I am uncertain how I feel.
- (4) I agree with the goals but disapprove of the methods.
- (5) I disapprove of the movement but am against repressive action.
- (6) I disapprove and would like to see the movement suppressed.

23. How do you feel about the conservation and ecology movements?
- (1) I support them and am active in them.
- (2) I favor them generally but have not been active.
- (3) I am uncertain how I feel.
- (4) I agree with the goals but disapprove of some of the methods.
- (5) I disapprove of the movements but am against repressive action.
- (6) I disapprove and would like to see the movements suppressed.

24. Do you think that there is any connection between all of these various movements in our society?
- (1) They are all aspects of one single wave of revolutionary change.
- (2) They may be related but are still separate movements.
- (3) I am uncertain what I think.
- (4) There is no connection between them.

25. Please give your age group.
- (1) teen
- (2) 20-24
- (3) 25-29
- (4) 30-39
- (5) 40-49
- (6) 50-59
- (7) 60 and over

26. Sex.
- (1) Male
- (2) Female

27. Education.
- (1) Eighth grade or less.
- (2) Attended high school but did not graduate.
- (3) High school graduate.
- (4) Attended business or technical school.
- (5) Attended three years or less of college or university.
- (6) Hold B.A. or B.S. college degree or about to graduate.
- (7) Hold M.A., M.S., or Ph.D. degree.

28. Annual family income from all sources.
- (1) Under $3000
- (2) $3000 to $5000
- (3) $5000 to $7500
- (4) $7500 to $10,000
- (5) $10,000 to $15,000
- (6) $15,000 to $25,000
- (7) $25,000 to $50,000
- (8) $50,000 to $100,000
- (9) Over $100,000

29. Occupation of the head of your household.
- (1) Manufacturing or distribution of products.
- (2) Construction, building trades, or real estate.
- (3) Retail, merchandising, or sales.
- (4) Engineering or technical.
- (5) Government or military.
- (6) Professional, education, or social service.
- (7) Farming, fisheries, lumbering, mining.
- (8) Banking or finance.
- (9) Transportation, communications, or utilities.
- (10) Arts or entertainment.
- (11) Other ________________.

30. What is the present level of work of the head of your household?
- (1) Director, executive, or administrator.
- (2) Assistant executive or administrator.
- (3) Supervisor, teacher, or foreman.
- (4) Clerical.
- (5) Craftsman, mechanic, machine operator.
- (6) Laborer or service worker.
- (7) Other ________________.

31. How often do you attend religious services or meetings?
- (1) Daily
- (2) Twice a week
- (3) Weekly
- (4) Twice a month
- (5) Once a month
- (6) Few times a year
- (7) Very seldom
- (8) Never

If you are active in the conservation and ecology movements or support them in any way, please complete the questionnaire. If not, leave the rest blank.

32. How many conservation, ecology, or other organizations concerned with environmental problems do you belong to?
- (1) None
- (2) One
- (3) Two
- (4) Three
- (5) Four or more

33. How often do you usually talk to other people involved in the movement (in telephone conversations, informal meetings, organizational meetings, etc.)?

- (1) Never
- (2) Few times a year
- (3) Once a month
- (4) Once a week
- (5) Twice a week
- (6) Three or four times a week
- (7) Daily

34. Of the five people you feel closest to, how many are also involved in the movement?

- (1) All five
- (2) Four
- (3) Three
- (4) Two
- (5) One
- (6) None

35. How many people have you personally influenced to become active in the movement?

- (1) None
- (2) One or two
- (3) Three to five
- (4) Six to ten
- (5) Over ten

36. How many people have you tried to interest in environmental problems by talking, making speeches, writing articles, etc.?

- (1) None
- (2) One to ten
- (3) Ten to twenty
- (4) Twenty to fifty
- (5) Fifty to one hundred
- (6) Several hundred
- (7) Several thousand

37. Write in the spaces provided the numbers of any of these methods of influencing decision-makers that you would approve of.

- (1) Writing letters to government officials.
- (2) Speaking at public hearings.
- (3) Lawsuits against corporations, government agencies, or individuals guilty of environmental negligence.
- (4) Boycotts against companies that pollute.
- (5) Rallies, marches, demonstrations.
- (6) Nonviolent direct action such as sitting in front of bulldozers.
- (7) Citizen take-overs of offices of government agencies or industries to enforce demands.
- (8) Destructive (violent) action, if other means failed (such as sabotage or bombings).

38. In your involvement with the movement have you ever had an experience that radically changed your ideas about yourself and made you act differently toward your environment?

- (1) No
- (2) Undecided
- (3) Yes, I have changed in some ways.
- (4) Yes, I have been radically changed.

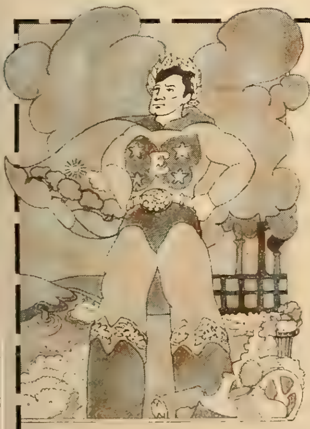
39. If your participation in the movement has involved any risks, write in the spaces provided the numbers of any of the following you have experienced.

- (1) Expenditure of great time or money.
- (2) Loss of friends.
- (3) Threatening mail or phone calls.
- (4) Pressure from employer.
- (5) Serious family rift.
- (6) Loss of job.
- (7) Destruction of personal property.
- (8) Jail sentence.
- (9) Bodily harm.

40. If involvement in the movement has caused you to change your life style in significant ways, please list such changes in the space provided.

41. Please list the conservation, ecology, or citizen's organizations active in environmental problems that you support or are active in.

Describe your role in each group (such as officer, committee member, full-time employee, sustaining member, etc.). Then describe the approach of each group by checking it as conservative, moderate, activist, or radical.



To:

Natural History Magazine

77 West 77th Street
New York, N.Y. 10024

Here are my answers to your questionnaire:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
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40. Changes in life style: ______________________________

41. Organization	Your role	Cons.	Mod.	Act.	Rad.

THIS GENTLE &

On the Serengeti Plains of East Africa the cheetah selects its prey carefully and kills it efficiently

By George B. Schaller

With its small round head, trim waist, and long, slender legs, the cheetah is the most atypical of the cats, an animal built for speed, a greyhound with the coat of a leopard. A delicate and aristocratic animal, it seems to belong with royalty; indeed trained cheetahs were used as early as 865 B.C. by King Hashing of Persia to hunt antelope. In the sixteenth century the Mogul emperor Akbar the Great of India is said to have kept 1,000 cheetahs. A hooded cat would be transported in a bullock cart to within 300 feet of a herd of blackbuck antelope. With the hood removed, the cheetah slipped off the cart, crept closer, and finally sprinted after the prey. If it missed, the keeper came up, chanting, "Oh, great King, do not be angry, you will kill the next one," as he slipped the hood over the cat's eyes. But if it captured an adult male, as it was taught to do, success was rewarded by a cup of blood from the slain animal.

Today this sport is extinct in India and so is the cheetah—the last one was shot there in 1952. A few survive in southwestern Iran and some possibly in Turkmenistan and in one or two localities in the Near East. Strays occur only occasionally in North Africa. Fortunately cheetahs are still widespread in the open woodlands and plains south of the Sahara where suitable prey survive. But they are nowhere abundant, not even in the national parks. The 5,000 square miles of the Serengeti in Tanzania contain

ELEGANT CAT

perhaps 150 cheetahs, one per 33 square miles; the large Kruger National Park in South Africa has about one per 27 square miles.

Considering the long contact that man has had with the cheetah, remarkably little was known of its habits until recently. Aloof and self-contained, it remained an enigma, even refusing to breed in captivity. Among Emperor Akbar's 1,000 cheetahs, only one had young, a litter of three. No other captive births were reported until 1956, and since then only seven litters have been born in zoos. When I joined the Serengeti Research Institute in 1966 to study predators, particularly the lion, in the Serengeti National Park, I became intrigued by the cheetah, not only by its mystery but also by its delicate beauty and lithe grace.

Most Serengeti cheetahs are migratory, following the movements of their principal prey, the Thomson's gazelle. During the rains early in the year, when the gazelles are on the plains, the cheetahs are there too, but when the grass dries up in July, both move 25 and more miles to the edge of the acacia woodlands that cover much of the park. There some cheetahs remain for several months. Occasionally one stays within a three- to four-square-mile area for a month, but usually each uses some 20 to 25 square miles of terrain in the course of a season. The same cheetah tends to return yearly to the same locality, and one of my pleasures was to recognize an individual after a long absence.

Cheetahs do not establish territories in the sense of defending a locality against other cheetahs. Several animals commonly range over the same area, but they avoid contact. When two see each other, they veer apart without associating. Cheetahs also squirt a mixture of scent and urine against tree trunks and often deposit their feces on prominent locations such as termite mounds. A cheetah that smells a fresh marker knows that the area has been visited recently and can then plot its movements to avoid a meeting. Cheetahs do not advertise their presence by roaring in the manner of lions. Their only louder calls are a birdlike chirp and a sedate, staccato chirr used mainly to

keep mother and cubs in contact with each other.

It has often been said that adult cheetahs are sociable and travel mainly in groups. I found this infrequently in the Serengeti. Excluding mothers with cubs, 52 percent of my sightings were of solitary individuals, 31 percent of the cheetahs were in pairs, and the rest in groups of three to four. Two or three adult males sometimes became companions for months, but I never saw two adult females in a group. Adult males and females associated mainly during courtship. Although I frequently saw groups of two to four males and females, these were with few exceptions litters of grown cubs that had not yet split up. The extent to which female cheetahs are asocial was shown well by a mother and her two grown daughters. Although all three wandered over the same area and sometimes saw each other, to my knowledge, they never met.

This particular family provided me with some of my most interesting observations on cheetah life history. The mother gave birth to at least three cubs in July, 1967, in a jumble of granite boulders and brush. By September she had only two cubs left. Most cheetahs lose about half of their cubs as a result of illness, predation, and abandonment, but a few manage to raise their whole litters of four to five. Her cubs, like those of all cheetahs, were black with a long blue-gray mantle of hair on their heads and backs, a striking natal coat that is lost at about three months. The cubs began to follow her around when they were about six weeks old; at three months they ceased to suckle. They were a close-knit family and shared kills without fighting. After a meal they licked each other's faces, purring loudly. Yet somehow their social existence seemed constrained; it lacked that intense quality of contact found among lions and even leopards. Perhaps it was because cheetahs do not rub their cheeks and bodies sinuously together in greeting, as lions and other cats do. Perhaps their tenuous social contacts as adults make an intimate bond between mother and offspring irrelevant. In fact, one observation suggests that mothers cannot recognize their young when they are small.

Once two mothers, each with two cubs about three months old, met inadvertently at a kill, then parted after briefly threatening each other. But one cub followed the wrong mother. She noticed the addition but could not distinguish the newcomer from her own. She cuffed any cub that approached her until all three cringed, and she refused to associate with them for at least eight hours. I was afraid that she would abandon all of them. Somehow the extra cub was reunited with its mother that night.

How to hunt was perhaps the most important lesson these cubs had to learn while still with their mother. At first they played around her while she stalked, sometimes alerting the prey by running ahead. But later, at about three months of age a change occurred. They followed discretely or watched while she hunted. A female may even provide her cubs with the opportunity to learn the techniques of killing. My wife, Kay, watched a cheetah carry a live gazelle fawn to her five-month-old cubs and release it. They tried to capture it, and once they knocked it down but were unable to kill it. Finally the mother did so. At the age of about one year cubs themselves will initiate some hunts. For example, in August, 1968, when she was 13 months old, a cub of the litter I had observed for over a year bowled over a gazelle fawn several times with a swat of her paw. But she was so inept at grabbing it that finally the mother ran up and killed it. In three subsequent hunts the mother took the initiative. On October 1, when they were almost 15 months old, the cubs bungled yet another hunt, only to be helped again by their mother.

Some two weeks later, on October 17, the family was still together, but on the following day the cubs separated permanently from their mother. It was a sudden and dramatic break, especially considering the cubs' inability to hunt well. There was no gradual severing of the social bonds, no tentative, solitary excursions, just an abrupt transition from dependence to complete independence. These cubs never again associated with their mother. Other litters behaved similarly. In contrast, the leopard, another solitary cat, behaves in a more typical manner. One female cub whose history I traced from birth began to occasionally roam on her own at the age of 13 months, but continued to meet and share kills with her mother until she was 22 months old. Three months later her mother conceived again.

The two cheetah sisters lost weight after separating from their mother, but they survived, and with the onset of the rains they moved to the plains. By February, 1969, they too had split up, for I met one as I was walking across the plains. She lay on her side, looking around with raised head in the curiously detached manner of cheetahs. I sat down 100 feet from her and fifteen minutes later heard a gazelle fawn bleat. Then over a rise came two jackals in pursuit of the fawn. The cheetah sprinted past me, knocked the fawn down, and grabbed it by the neck. She had obviously learned to hunt. As she ate I moved slowly toward her, finally reclining fifteen feet away. She stared at me with

Thomson's gazelles scatte
before the charge of a cheetah
The cat already has singled ou
its victim from the herd

Tense and intent, a cheetah
stalks toward its prey on the
grassy plains of the Serengeti.

guileless, amber eyes but did not flee. We stayed together for over half an hour, once only ten feet apart, one of my most memorable experiences with a wild animal.

One of these young females conceived in April, 1969, when 21 months old, and her sister courted in May. A tame but free-living cheetah raised by Joy Adamson also bred at the age of 22 months for the first time. On July 12, I found the litter of the first young female: four cubs only a day or two old, with eyes still closed, weighing a mere 12 ounces each. They lay in a patch of grass six miles from the place where their mother was born two years earlier. She was just moving the cubs to a thicket 900 feet away, carrying them one at a time by the back or a leg. After all had been moved, she returned twice more and searched the site, seemingly unable to count with precision. At the age of three weeks the cubs could walk unsteadily. On August 19, the photographer Simon Trevor saw her take the cubs to their first kill. The gazelle was not dead and the cubs were obviously frightened, jumping back each time it kicked. Another generation had to learn to become a predator.

The hunt of a cheetah is surely one of the most exciting spectacles in Africa—the slow stalk, the tense period of waiting until the prey is inattentive, and finally the explosive rush at speeds of at least 60 miles per hour, making the cheetah the fastest of all land mammals. Cheetahs may hunt at any time during the day, and on moonlit nights as well, but usually they do so between 7:00 and 10:00 A.M. and 4:00 and 6:00 P.M. They seldom work hard for their meals, but lie in the shade, seemingly waiting for prey to drift into the vicinity. Or from a termite hill, they scan the horizon for prey and then slowly walk in its direction. At some time between spotting a possible quarry and chasing it, the cheetah selects one, and I was

The charge. No animal can run as fast. But the cheetah tires quickly and can run no more than about 900 feet at full speed.

particularly interested to find out what determined that choice.

Size of prey was obviously one factor. In the parts of the Serengeti where I observed cheetahs, Thomson's gazelle was the preferred prey (91 percent), followed by Grant's gazelle, wildebeest, impala, and hare in that order. A Thomson's gazelle weighs some 35 to 40 pounds, just one large meal for a cheetah weighing 110 to 130 pounds. Adult Grant's gazelle, impala, and reedbuck were also killed, but of the wildebeest only the calves were captured. Similarly, some 68 percent of the cheetah kills reported from Kruger National Park consisted of impala, and most of the other prey was relatively small too. A cheetah hunting alone seldom preys on anything weighing much more than itself and this limits it to the small antelopes and the young of the large ones. But several cheetah together may attack a large animal, as in Nairobi National Park where four males killed kongoni and zebra.

Prey selection can operate in two ways. In one, the predator chooses a particular animal out of a herd—a sick one, a newborn one—and pursues it, ignoring all others. In the other, the prey selects against itself, so to speak, by becoming vulnerable in some way. Leopards, for example, catch nearly twice as many adult male Thomson's gazelles as would be expected from their number in the population. These seem to be mostly nonterritorial males that roam through high grass and along river courses where leopards hunt, in contrast to females and territorial males that remain in areas of short grass where they are not so vulnerable to leopards.

Cheetahs hunt mainly in the open plains. There they catch about 30 percent fewer adult males than expected, possibly because cheetahs prefer to select prey that is fleeing rather than standing around alertly as territorial males do. I collected and aged the jaws of 163 gazelle kills. The cheetahs had captured many fawns less than six months old, whereas yearlings, some 9 to 24 months old, were almost immune to predation. The cheetahs took many adults but no age class was particularly selected. Most of the adult prey taken were presumably healthy, although the cats may have been able to detect slight disabilities, which I could not. Gazelles sometimes suffer from heavy infestations of lungworm or sarcoptic mange and such animals possibly respond less briskly to the cheetah. However, when the ages of gazelles killed by cheetahs are compared with those killed by lions, it is obvious that the two cats select very similarly. A lion captures its prey by surprise in a short fast rush, during which there is little or no time to test for weakness in an

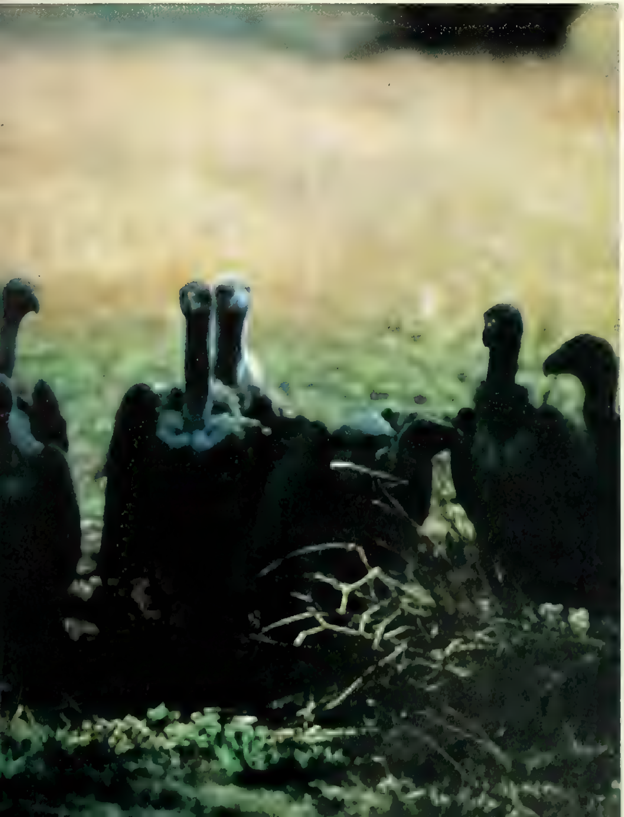
Alerted by circling vultures, a lion drives a cheetah away from its prey. Lions occasionally kill cheetahs.

individual. In contrast, the cheetah may take its prey with a long run. Despite their different hunting techniques the adult gazelles killed by these two cats had a similar age structure, except that lions kill fewer small young and more yearlings. Possibly cheetahs catch the sick, and lions, the healthy, but I am inclined to think that most prey selected by both species was in reasonably good condition.

When observing a cheetah hunt, the selection for fawns is obvious—any fawn in a herd is immediately pursued. This is not surprising when hunting success is considered. Although cheetahs can attain tremendous speed, they are unable to keep it up for more than about 900 feet. If the gazelle dodges several times, the cheetah, exhausted, may have to give up the chase, and 23 out of 26 unsuccessful hunts that I observed failed for that reason. A fawn can run neither fast nor far, and in 31 chases after them, the cheetah was successful every time after an average run of 600 feet. On the other hand, of 56 pursuits after large young and adults only 54 percent resulted in a kill after a chase up to some 900 feet. Cheetahs are pragmatists: better a small meal than none at all.

Cheetahs prefer to hunt a solitary individual or one in a small herd, because they have difficulty selecting a gazelle and keeping it in sight in a large, milling herd. Individuals that enter tall grass, graze behind some bushes, or otherwise enable the cheetah to stalk undetected are chosen. With endless patience the cat may wait for a gazelle to lower its head and graze while briefly facing away from the danger, thus giving the cheetah an undetected second during the rush—often the difference between success and failure. The selection process is not always an easy one. Cheetahs sometimes bound toward a herd, then give up for no obvious reason, probably because they are unable to find a suitable quarry. Or they first pursue a herd at moderate speed before suddenly making a selection. Here are two typical hunts:

A female cheetah climbs ten feet up a tree and spots ten gazelles about 700 feet away. She approaches the herd slowly, with head held low, until she is some 300 feet from the animals. She sits and watches for five minutes. One gazelle grazes somewhat apart from



A phalanx of vultures watches a cheetah and its victim. The cat usually eats about 60 percent of a carcass.

the herd. The cheetah rushes and is within 100 feet before the gazelle flees. After a chase of about 480 feet, which includes a sharp 180-degree turn, the gazelle flips forward, tripped by the cheetah, which lunges in and grabs the throat. After five minutes, the gazelle dies from strangulation.

A female cheetah spots a dozen gazelles on a burned stubble 800 feet away. She slowly walks 300 feet toward them; then, at a moderate speed, bounds about 500 feet before selecting the smallest individual in the fleeing herd. She sprints after it, follows three zigzags closely, and after 400 feet, catches it in a cloud of dust. She emerges holding it by the throat.

After knocking a gazelle down by hitting its flank or rump with a paw, the cheetah typically grabs it by the throat and throttles it, a task that requires four and a half minutes on the average. The carcass is often dragged to a shady spot. Cheetahs usually eat the meat off one thigh first; after that they cut the meat from the abdomen and rib cage, sometimes stopping to lap up any blood that collects in the body cavity. Finally they strip the rest of the meat from the inside. All that generally remains is the articulated skeleton with much of the skin and the whole digestive tract. The cats eat rapidly, glancing nervously around at intervals. This is not surprising, for lions, hyenas, and other predators often arrive at the kill, having been alerted by the descending vultures that a meal is in the offing. Cheetahs are timid creatures, low in the predator hierarchy, and 12 percent of their kills end in someone else's stomach. Twice I saw a cheetah driven from its kill by a solid phalanx of vultures. The cheetahs did little to retaliate when their kill was scavenged except to hiss and moan in a peculiar manner, although one bold hyena was slapped in the face.

To find out how often a cheetah kills, several persons with the Serengeti Research Institute and I watched a female with two small cubs for 26 days. There is a primitive pleasure in spending a day with a predator. Nothing happens for hours. The plains shimmer with heat waves. Yet there is a tension in the air, a feeling of impending violence. During these 26 days the cheetah killed 24 Thomson's gazelles, ranging from small fawns to adults, and one hare. At this rate she would kill 337 gazelles per year. She caught nothing on three days, although she tried, but on two days she captured two gazelles each. She captured an average of 22 pounds of animal per day, but she lost two kills to lions and one to hyenas. About 40 percent of the weight of a carcass was not eaten. mainly the digestive tract and bones. This left about 11½ pounds of meat for the mother and two cubs, almost twice as much as she actually needed, judging by the amount fed to cheetahs in zoos. Other mothers killed equally often, but solitary cheetahs captured prey probably only once every two to three days. Taking into account the size of the cheetah population, the percent of gazelle in their diet, and other factors, it seems likely that the Serengeti cheetahs kill 15,000–20,000 gazelles a year, only a small percentage of the several hundred thousand gazelles in the park.

Given such a large amount of prey and their success in catching it, there were surprisingly few cheetahs in the park. The Nairobi National Park, only 44 square miles in size, usually had some 10 to 15 resident cheetahs, showing that the species can tolerate quite high densities. Adult females outnumbered males by a ratio of 2:1 and one-third of the females were accompanied by cubs, often large ones. Females that lose their litter may come into estrus again within a week, and the gestation period is only 90 to 95 days. The Serengeti cheetahs have a high reproductive potential, a satisfactory number of cubs are raised, and food seems to be no problem. Yet something keeps the population depressed at a low level. A leopard killed and stored a cheetah in a tree, several lions captured and strangled one, and a litter burned in a grass fire, but such deaths were insignificant to the total cheetah population.

The wild dog, an equally rare predator in the park, provided a hint. These pack-living predators raised large litters, but canine distemper killed over half the members of one pack and undoubtedly affected other packs as well. During my stay in the Serengeti the wild dog population did not increase. It had failed to increase since at least 1956, the period for which there is information. The dog population seems to be controlled by disease, not by the food supply. Possibly cheetahs are also affected by disease, although I have no evidence to show this. The basic question of just what factors operate on the dog and cheetah populations to keep them stable at such a low level remains unanswered. Disease can cause a decrease but something else must finally determine that level at which the population stabilizes.

The cheetah is uncommon to rare everywhere, and the species balances itself delicately between security and extinction in an area. Any additional mortality, such as shooting by man, may well have a serious effect on a population. Yet in 1966 75 cheetah coats were sold in New York alone to satisfy the vanity of a few women. A total of 3,168 cheetah skins were imported into the United States in 1968–69, as many as would normally be found in 98,525 square miles of Africa, given the densities in Kruger and Serengeti national parks. Unless the cheetah is more strictly protected, this gentle and elegant cat will surely follow its Indian cousin into extinction over much of Africa.

A cheetah cub is born with a black coat and a mantle of long blue-gray hair. The natal coat disappears at about three months of age.

Tiny Wolves of the Water

The barely visible water mite, a colorful carnivore, leads a complex, predacious life

by David Barr

Photographs by Helen Sutton

On the hunt for prey, mites of genus *Limnochares*, top, move through aquatic vegetation. Bottom, the male mite *Arrenurus*, magnified about fifty times, is heavily armored.

To slip beneath the calm surface of a marsh or pond is to enter a new world, a complex world inhabited by armored and jointed creatures, by serpentine segmented worms, by larvae, nymphs, and scuttling adults of many kinds. And in this profusion of freshwater invertebrate life the most colorful creatures by far are the water mites. Most people generally see the conspicuous, bright-red members of this group, but there are many lesser-known common water mites, richly patterned in tones of brown, yellow, blue, green, violet, and magenta.

All are tiny: the largest no more than a quarter of an inch long; the average, about a sixteenth of an inch. Observations of water mites usually have to be carried out with a low-power microscope.

At first glance, a water mite could be mistaken for a small aquatic spider. In fact spiders and mites, which are grouped together as arachnids, share a number of important features. Both have piercing jaws, the chelicerae, and a pair of sensory, accessory mouthparts, the pedipalps. Like the spider, the mite possesses four pairs of legs used for locomotion, and is a carnivore, sucking the body juices of its prey. The most obvious difference between the two arachnids lies in the spider's narrow waist, which divides its body into two main sections. All water mites have an undivided body.

Like most freshwater animals, mites are a little heavier than water. While some species live on the bottom of the pond, others swim easily with the aid of long, brushlike tufts of hair that increase the surface area and improve the efficiency of the legs for aquatic locomotion.

Adult water mites are free-living and predacious—the wolves of their world. On a sunny day a relatively large, bright-red water mite, such as *Eylais*, can be seen swimming, legs flailing like a miniature windmill, on the hunt for tiny crustaceans. The mite will enter a browsing school of its translucent prey, seize one with the strong, clawed pedipalps, and drop in a crimson arc to the pond bottom.

The crustacean prey is pierced by the needlelike mouthparts, and the mite feeds on its body juices. Soon, the meal over, this voracious predator returns to the hunt, aided by two pairs of simple eyes usually placed above the mouth, one pair on either side of the body. In some cases all four eyes are mounted together on a central plate, and in several primitive families, a fifth eye is present as well.

An animal that requires a microscope for its observation is not easily studied. To begin with, specimens are difficult to gather. One way to obtain large numbers of water mites for observation is to dip into a weedy pond with an aquatic insect net. In such a favorable habitat mite population densities may approach hundreds per square meter. When plant and animal material taken from the bottom of the pond is dumped out in a shallow, white-bottomed pan of water, mites swim out of the mass of vegetation. They can be picked up with a medicine dropper, one at a time, and transferred to a collecting vial.

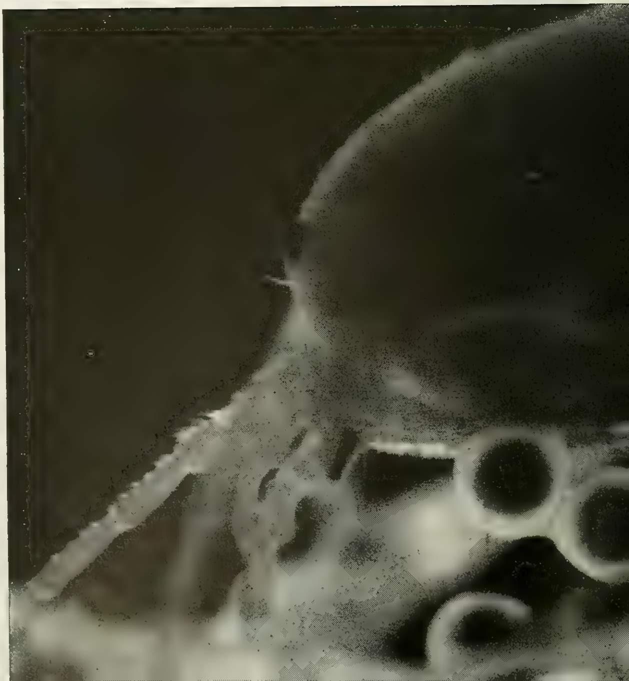
Water mites have a wide variety of different habitats and different ways of life. Stream-living mites often congregate in clumps of submerged moss or in masses of tree rootlets projecting into the water. Because they lack the holdfast devices that enable many insects of this habitat to avoid being swept away, mites invariably seek a spot sheltered from the current.

Aquatic mites even manage to eke out a living where there seems to be no water at all. There are many natural situations where water exists only as a thin surface film, places such as the lush banks of moss kept constantly wet by spray from a waterfall, the damp shoreline of a lake or pond, or the soggy surface of marshy ground. Mites of the water-film habitat do not swim, but have short, strong, spiny legs for crawling laboriously along the surface. There is no way to collect them except to get down on your hands and knees, and pick them up one by one with a pair of soft forceps.

A few persistent water mite collectors have located substantial populations of small, pale-colored mites in the underground water that flows around the gravel particles and sand grains beneath stream beds. One biologist has a foolproof method for determining whether a gravel bar is a good collecting spot. With hip boots and collecting gear, he wades out to the bar, then with each step, bounces up and down, first on one foot, then on the other. If the surface feels spongy, so that his boots sink in an inch or two, there will be enough water flowing among the gravel particles to support a good mite population.

Adding to the difficulty and challenge of studying water mites are the complex life cycles characteristic of these creatures. While many terrestrial mites are either parasitic or predatory, water mites demonstrate their versatility by trying out both styles during the course of a life cycle. There are usually at least six readily distinguishable life history stages: egg, parasitic larva, first chrysalis (nymphochrysalis), nymph, second chrysalis (teleiochrysalis), and adult. Each stage of each species has a characteristic appearance and way of life—and there are at least 5,000 species of water mites.

I feel challenged each time I examine a field collection of water mites. It usually contains male and female adults of a variety of species, some of them closely related. Each mite, for example, a fast-



An egg-laden *Unionicola* drifts, slowed by elongated, radiating legs. Leg hairs improve the locomotive efficiency.

swimming, blue-green female of the genus *Arrenurus,* poses questions: what is the male of the species like? when are the eggs laid? what does the larva look like? which insect serves as host? into what kind of nymph does the larva develop? These questions lead toward a larger goal: to understand the place of the species in the habitat and its relationship to the other organisms there. Thus the first step in the study of a water mite ecology is to establish a complete set of life history stages for a species.

In examining a field collection suppose one discovers a mite for which only the male is known to science. The first step in tracing the life history of mite X is the analysis of numerous collections of adult mites. It is often possible to decide which male and female form belong to the same species from the observation that they are always found together. If, in addition, the same type of male and female mate readily when kept together in an aquarium, one can be fairly certain that they are conspecific. Such a male–female association is the first of a series of links in a life history.

In the laboratory, female mites will lay spherical red or yellow eggs, deposited singly or in large masses, but always invested with a gelatinous envelope. In nature, these vermilion egg clusters are glued on submerged plants or on stones, dead leaves, or bits of twig; but in the laboratory they are usually deposited on the walls of the aquarium or glass dish in which the mites are kept. Thus one can watch the hatching of the egg, and, when it appears, examine the next important life history stage, the larva. The larvae are extremely small and can be examined carefully only under the highest magnifications of a compound microscope. They usually have the same kind of mouthparts as the adults, but unlike adults, the larvae have just three pairs of legs.

The water mite larval stage is typically parasitic upon one or another variety of aquatic insect—a dragonfly, a water bug, a beetle, or a mosquito. If the adult host spends most of its time in the water (beetle, water bug), the mite larva attaches its mouthparts directly into some part of the insect body. But if the adult host is aerial (dragonfly, mosquito), the larval mite has to contact the insect at an immature stage, when it is aquatic. The contact may be made underwater or at the surface when the insect is leaving the water in preparation for its transformation to the adult form. Thus the glistening, last subadult stage of an emerging insect often carries several dozen tiny, red or green, hitchhiking mite larvae out of the water with it. As the immature host insect sheds its exoskeleton a final time, the mite larvae quickly crawl to the pale, newly hatched adult and before the body hardens, they plunge in their mouthparts.

So far it has proved difficult to induce mite larvae to attach to a host insect in the laboratory so that they will engorge and change into nymphs. This makes the larva→nymph step a critical one, requiring

Emerging eggs, magnified about eighty times, sink to an underwater plant. Most mite larvae, when they hatch, become parasites on insects.

intensive field collecting of all kinds of aquatic insects. A graduate student working on just such a project learned that it can be tougher than it sounds. He suspected that his mites were using aquatic beetles and bugs as hosts. But the percentage of parasitism was so low that time after time he had to collect and examine several hundred insects to find a dozen or so that were parasitized.

In the laboratory, parasitic larvae, looking like tiny red balloons decorating the host body, can be removed and their detailed structure compared with that of the larvae hatched from eggs. If the two are identical, one then knows the host insect (or at least one of them) for this species.

When the larva is fully engorged it enters a resting stage called the nymphochrysalis, analogous to the pupa of butterflies and moths. Inside the old, distended larval skin, a series of drastic anatomical alterations occur, and a new life stage, the nymph, forms. When fully developed, the nymph simply ruptures the old larval skin and drops off, leaving behind a stalk of larval mouthparts attached to the host insect. Probably some precise behavioral mechanism allows it to do this only when the host is flying over or swimming in a body of water. The larvae so laboriously located on field-collected host insects complete their development in just this way. If the hosts are kept in or over water, the newly hatched nymphs will drop off and swim around in the container, where they can be collected for examination.

The nymph is like a miniature edition of the adult mite with four pairs of legs and similarly shaped mouthparts and body plates. It usually differs only in lacking an opening in the genital region and in having genital plates that are of reduced complexity.

The nymph also imitates nearly the adult mode of life, swimming or crawling through its habitat, voraciously capturing and consuming its natural prey of smaller invertebrate animals. When it has fed enough, it climbs onto a bit of vegetation, wraps its legs tightly around the stalk, and enters another mummylike, quiescent period, called the teleiochrysalis. Inside the nymphal skin the new adult takes shape, and when this transformation is completed, it ruptures its prison and bursts forth to take up a free-living, predatory existence once more.

When the nymph→adult step is established and the life history association complete, a chart can be drawn for the entire life cycle of the mite. This is the first step toward understanding its place in the complex aquatic ecosystem.

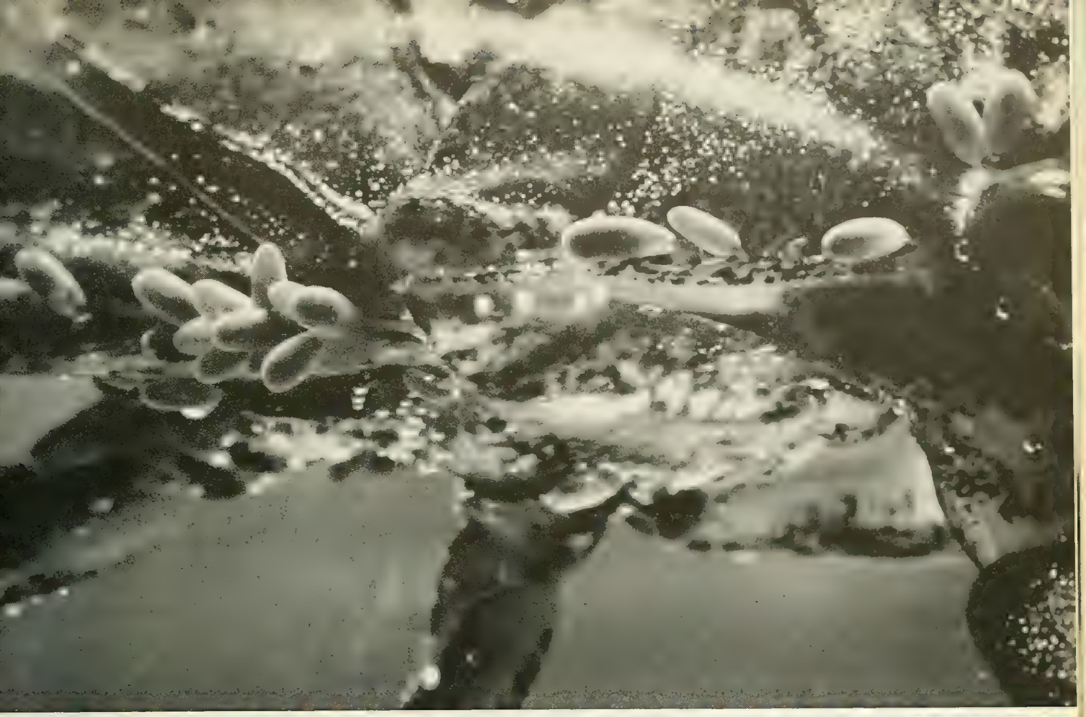
Certain water mites alter the basic life cycle I have described. For instance, females of some species have the remarkable ability to lay eggs in which the larva forms but never hatches. While still inside the egg cuticle, the larva is transformed into a tiny nymph, and when this hatches it can begin searching immediately for prey. By this device the mite gives up parasitism and avoids the risk of not being able to find the right host at just the right time. Still other genera have evolved a magnificently individual adaptation and parasitize aquatic mollusks, especially freshwater mussels or clams. All stages, with the exception of the active larva, may be found inside the mussel, embedded in its fleshy gills or labial palps.

It is just possible that a knowledge of water mite life histories will be of great practical interest to mankind one day, aside from the insight it now gives into the working of freshwater environments. Water mites attach to a wide variety of insect hosts, among them some that most plague man: mosquitoes and blackflies. There are indications that heavy infestations of parasitic mites can seriously weaken host mosquitoes, even prevent them from reproducing. The remote possibility of using water mites to control troublesome insects suggests a welcome alternative to insecticides.

Mite larvae, looking like balloons, enter a resting stage on their host, a giant waterbug.

Moreover, the spectrum of mites that inhabit freshwater can serve as a delicate indicator of the level of organic pollution in natural water sources. Mites are sensitive to changing water quality. A biologist studying communities of stream mites in western North America discovered that the addition of treated city sewage to a mountain creek reduced the mite populations almost to zero for several miles downstream, and that below the point of sewage outflow the mites never built up to their natural numbers again. To read the subtle story of pollution levels in aquatic habitats, however, we first have to know much more about what constitutes a natural water mite population, an impossible task in the absence of a complete life history picture for each of the species present. Thus, a deeper acquaintance with the richly varied, colorful animals that live in natural, clean freshwater may serve to protect this habitat for both mite and man.

Leaving its nymphal skin attached to an underwater stalk, the mite *Eylais* begins a predatory adult life.



Barrier Beaches of Eastern America

By shifting constantly, these narrow sand islands survive the fury of Atlantic storms. The works of man are less durable

by Christopher J. Schuberth

A slender ribbon of light-colored sand, about thirty miles long and less than a mile wide, arches gracefully southward from Long Island and pierces the dark blue waters of the Atlantic Ocean. Cartographers call it Great South Beach, but to most New Yorkers it is known as Fire Island. Fire Island is the northernmost segment of an almost continuous chain of low barrier islands that extends from New York to Florida. Similar barrier chains line much of the Gulf Coast, the North Sea coast of Holland, and the Baltic Sea coast of Poland. In the United States a number of important industrial and resort cities—Galveston, Miami Beach, Atlantic City, to mention three—have developed on these islands.

Unlike the immobile rock ramparts of the New England coast, the barrier beaches respond sensitively to the changing forces of the coastal environment. Occasionally they founder temporarily beneath the abnormally high tides and gale force winds that accompany intense coastal storms or tropics-spawned hurricanes. But more often, these fragile lines of sand maintain the mainland's outer defense against a dynamic and aggressive sea.

Vacationists in ever increasing numbers continue to flock to these islands. On Fire Island the growth of summer communities has been so rapid that land for new seaside homes is almost nonexistent. The Fire Island National Seashore, established in 1967, now maintains in a natural state all the undeveloped land of the barrier island outside the borders of Smith Point County Park, Robert Moses State Park, and the thirteen established communities. This has increased the demand for land within the communities and has inflated prices tremendously.

Natural, ocean-facing dunes of windblown sand, so vulnerable to wave erosion during times of severe storms, yet so essential for the protection of the island's interior, have become the most highly prized parcels of real estate. Hundreds of

Waves from a late November, 1969, storm, which removed a protective dune, swirl beneath precariously perched summer homes at Westhampton Beach, New York.

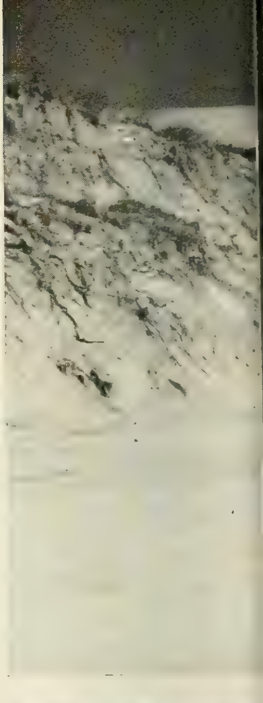
summer homes, including many expensive ones, have occupied these protective dunes. In many places these homes, with their spindly supportive legs, now stand exposed to the full fury of storm-driven waves. Senseless tampering with protective dunes has made many of the island's interior communities susceptible to an invasion by the sea. Much is at stake, both in terms of personal financial investments—now totaling several tens of millions of dollars—and the stability of the island itself.

The geologic processes that shape a barrier island do not change with the arrival of man. The complex coastal processes—their broad patterns and detailed variations—are part of an ongoing history of physical change in which neither of the antagonists, waves nor beaches, gains a permanent victory. The process of sand transportation within the surf, for example, is a response by the beach to the changing pattern of breaking waves. The problem for man is not the movement of sand as such, but rather its movement away from areas where it is needed for the protection of expensive homes. When the oceanfront was unoccupied, the beach could shift without alarming anyone. Now, with the presence of houses and other fixed objects against which shoreline changes can be measured, island dwellers become dismayed by the loss of their sand.

In futile attempts to maintain shoreline stability and protect property on the barrier beaches of Long Island from wave damage, millions of dollars of private and public funds are periodically invested to replace sand removed by wave action. Dredged out of the shallow, backwater areas of Great South Bay, sand is pumped onto the oceanfronts of troubled communities. Within a few years, this expensive sand is swept away to collect, unwanted, in other areas. The endangered properties remain in the same hazardous position, and the additional sand often moves to inlets and other navigational channels where it is not wanted. To aggravate this situation, the source of dredgeable sand is not endless. Already nearly all available sand has been removed from some areas in Great South Bay.

The so-called erosional problem involves normal, well-understood geologic processes, which have been in operation since the barrier first formed some 5,000 years ago. These same coastal processes continue to reshape the shorefront despite the presence of man and his works. It is only when man comes to cross-purposes with the natural design of change, when his developed real estate is threatened by normal, ongoing geologic processes—volcanism, earthquakes, landslides, the shift of a barrier island—that these processes take on alarming new dimensions and become geologic hazards. But, if man presses closer to the flanks of active volcanoes or straddles regions of seismic instability (such as the San Andreas Fault in California), if he develops housing atop unstable rainsodden slopes in the Pacific Coast ranges, or pushes onto the protective dunes of the wave-moved barrier sands, does he have the right to consider the effects of these natural processes as hazards? Since man is the transgressor, is it not more realistic to consider the hazards involved as human?

To cope with the problems of coastal erosion, we must define three basic terms before we can understand the significant geologic processes involved. A barrier island is an elongate ridge of unconsolidated sand, often dozens of miles long and between a few yards to a mile



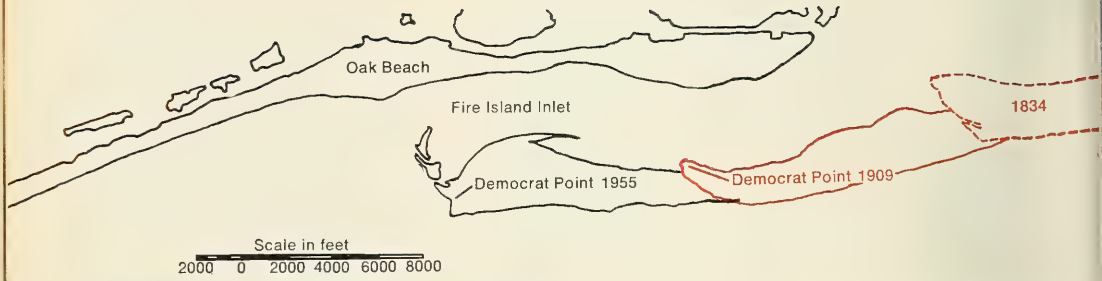
Top: In the spring of 1961 a dune and berm protect an oceanfront hotel on Fire Island. Bottom: After a storm in March, 1962, the damaged hotel stands exposed to the Atlantic. The littoral current swept away more than 75 feet of sand.

wide, that generally parallels the mainland shore. Its sea-facing dunes, if naturally formed from windblown sand, rarely rise more than fifty feet above high water. The barrier is separated from the mainland by a shallow bay, or lagoon, which may be several miles wide. Each barrier island is separated from the next in the chain by a tidal inlet, rarely more than a mile wide.

The geologist defines a beach as the whole downsloping zone of oceanfront in which sand is in a near-constant state of movement by ordinary wave action. Thus, a beach extends from the normal high-tide line to a depth of water generally not exceeding 30 feet below low tide. Below 30 feet in depth, wave motion, even during a severe storm, rarely stirs the sand. The familiar part of the shore, the near-horizontal terrace of heavily trampled sand that extends seaward from the foot of the dunes to the high-tide line, is known as the berm. It is built up by sand brought ashore through the turbulent action of breaking waves.

The problems of oceanfront residents result from the energy released by the continual breaking of ocean waves. More than 8,000 breakers pound Fire Island's beach every day—an average of six each minute—with a force of as much as 2,000 pounds per square foot. When ocean waves move into shallow water, usually less than 30 feet deep, the circular orbit of their water particles is distorted. As each wave steepens, and becomes asymmetrical, the distance between crests decreases. Continuing landward, the ever steepening wave becomes so distorted in the shallow water that its crest curls over, and the wave breaks with a thunderous crash to form the white, frothy surf. A swirling mass of sand-laden water, the swash, is hurled across the exposed beach face. When the energy of the swash is spent, a less turbulent flow of water returns to the sea and on out to the breaker zone as a below-surface undertow, which is recycled landward with the next breaking wave.

Most of the breaker's energy is



Westward Growth of Democrat Point

released in the strong turbulence of the surf and swash. In this turbulent zone, untold numbers of sand grains are dislodged and moved about in such a pattern that they never return to their original position. Moved, for example, a tenth of an inch with each breaking wave, an individual sand grain could migrate in the surf as much as 100 feet in a day.

A sand grain follows two broad patterns of movement along the beach. The swash pushes a sand grain up the beach face, while the backflow carries it seaward. But sand grains rarely follow a straight up-and-down path. As each sand grain moves landward and seaward it usually also moves parallel to the beach.

The distance and the direction that sand grains move are related to the coastal conditions of summer and winter seasons. During the summer, waves are usually low, the surf is not turbulent, and the corresponding swash is a thin sheet of gentle water. Few storms occur. Under these quiet weather conditions, friction will hold sand grains against the bottom during the gentle backflow of water, and most are not carried back in the undertow to the breaker zone. As a result, the net movement of sand is landward. Beginning in early summer, billions of sand grains along the length of beach slowly build up a broad terrace, known as the summer berm, which widens as the season progresses. Throngs of bathers enjoy the wide berm and swim in the gentle surf during July and August. And the widening summer berm may relieve the anxieties of oceanfront property owners.

But the existence of a wide berm is short-lived. From late fall to early spring coastal storms, often as many as one a month, churn up the Atlantic waters. In the long run, these produce the great physical changes along the oceanfront. High waves force a great volume of turbulent water across the beach and onto the summer berm. The strong turbulence keeps sand in suspension so that the powerful countercurrents of backflow carry the sand out to the breaker zone. Behind the breaker zone, in the deeper, less turbulent water, most of the sand accumulates. It forms an offshore bar, a low underwater ridge of sand that parallels the shore. As the bar grows in height, the waves break farther offshore and turbulence scours the top of the bar. Although usually seen only at extreme low water, bigger waves break initially over the offshore bar; lower waves re-form in the deeper water landward of the submerged bar, only to break finally along the winter beach.

Intense winter–spring storms with onshore winds of gale force often produce high tides and chaotic patterns of breaking waves. A turbulent surf and a powerful swash flood the winter berm and often tear into the dunes, removing tens of thousands of cubic yards of sand. During the March 6–8, 1962, storm, the surf, with unusually high 30-foot waves, swept away 96 dune homes and severely damaged another 195, from Fire Island east to Montauk Point. Waves breached dunes at 50 places, exposing the back dune areas to intense wave erosion. Three thousand feet of roadway at Westhampton Beach were destroyed; a new tidal inlet, over 1,200 feet wide, was created where formerly developed properties existed; and about 70 feet of beach, berm, and dunes were wiped off the map. An estimated 350 homes were destroyed as far south as Virginia, over 20,000 sustained major wave damage, and property losses exceeded $234 million.

Six years later, in November, a small coastal storm inflicted $2 million in property damage and removed over $900,000 worth of sand fill designed to protect ocean-facing homes along a half mile of Westhampton Beach. Thirteen months later, during the "Christmas Day Storm," an additional half dozen homes were destroyed in two Fire Island communities.

Yet, during this seven-year period, not a single hurricane threatened the coastal region, a most unusual and fortunate circumstance, for if one had, wave erosion and wind damage would have left the now-unprotected communities in shambles.

After each storm the beach and berm undergo partial recovery. The dunes may suffer more permanent damage because vegetation must take hold again to keep the blowing sand in place. Over the next several days a less turbulent surf, almost contritely, returns some of the offshore sand as each wave, stumbling over the submerged bar, lifts sand grains into suspension. Moved forward in the next breaking wave, the suspended sand slowly advances landward. The narrow, concave early poststorm profile of the shorefront is altered to a wider, convex late poststorm profile. However, this widening and filling in of the berm over the next few weeks is often interrupted by another storm. Over the entire winter–spring season, much of the sand of the summer berm remains in the submerged bar.

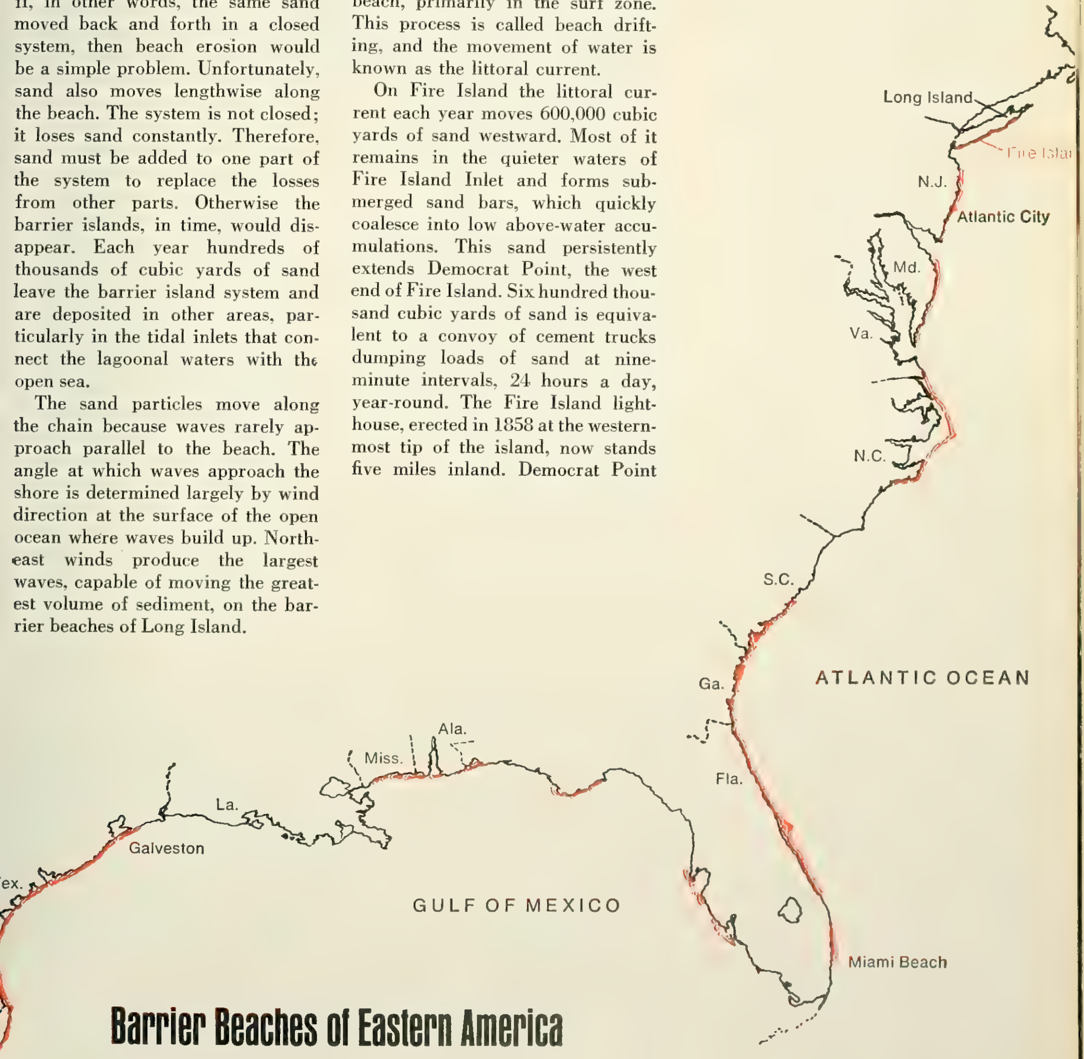
If the sand moved only in a straight line away from the shore in the winter and back in the summer; if, in other words, the same sand moved back and forth in a closed system, then beach erosion would be a simple problem. Unfortunately, sand also moves lengthwise along the beach. The system is not closed; it loses sand constantly. Therefore, sand must be added to one part of the system to replace the losses from other parts. Otherwise the barrier islands, in time, would disappear. Each year hundreds of thousands of cubic yards of sand leave the barrier island system and are deposited in other areas, particularly in the tidal inlets that connect the lagoonal waters with the open sea.

The sand particles move along the chain because waves rarely approach parallel to the beach. The angle at which waves approach the shore is determined largely by wind direction at the surface of the open ocean where waves build up. Northeast winds produce the largest waves, capable of moving the greatest volume of sediment, on the barrier beaches of Long Island.

A wave from the northeast breaks from east to west. The uprush of water from the breaking wave, plus the sand particles, moves obliquely up the beach face. But the return flow and the sand particles follow a straight path down the beach face. When moved by the next swash, the sand grains follow the same stepwise pattern. Multiplied by countless repetitions on a seemingly infinite number of sand grains, this action transports a vast amount of sand along the entire beach, primarily in the surf zone. This process is called beach drifting, and the movement of water is known as the littoral current.

On Fire Island the littoral current each year moves 600,000 cubic yards of sand westward. Most of it remains in the quieter waters of Fire Island Inlet and forms submerged sand bars, which quickly coalesce into low above-water accumulations. This sand persistently extends Democrat Point, the west end of Fire Island. Six hundred thousand cubic yards of sand is equivalent to a convoy of cement trucks dumping loads of sand at nine-minute intervals, 24 hours a day, year-round. The Fire Island lighthouse, erected in 1858 at the westernmost tip of the island, now stands five miles inland. Democrat Point continues to extend westward at an average rate of 212 feet each year.

Beach drifting is man's major problem on any barrier island that undergoes intensive development. Coastal erosion costs the United States approximately $150 million annually. For many years, the accepted method of dealing with this problem was to build groins, damlike rock structures a few feet high and about a hundred feet long, per-



Barrier Beaches of Eastern America

To save threatened real estate, a bulldozer and dredge (above) move sand from the surf zone to the berm at Point O'Woods, Fire Island. Such efforts are usually futile, as shown in the sequence from the same community. When the dune (top) diminished in May, 1962, the community added sand from the interior lagoon to build up the dune in January, 1963 (middle). By February, 1964 (bottom), it was gone.

pendicular to the shoreline. Sand is trapped on the updrift side of the groin, and the berm and beach widen quickly. But the sand supply is thereby reduced and, on the downdrift side, the beach and berm must retreat. So, another groin is needed "downstream" to trap whatever sand is available in the littoral current. The beach and berm begin to retreat downstream from the second groin. So another groin is built, and another, turning a former unsullied stretch of shore into a field of ugly groins. The groins create a series of curving, flotsam-retaining berms and beaches.

The effects of groins are local and temporary. Owners of oceanfront properties in immediate danger of being washed away are understandably eager to see fast action and quick solutions in the hope of restoring their beach. But too often changes are made without realizing the consequences. Groins may easily accelerate erosion. Eleven groins recently completed along Westhampton Beach had this effect. Intensified wave action on the downdrift side of the westernmost groin was the primary cause of the $2 million in property damage during the November, 1968, storm and an estimated $900,000 loss in sand fill.

Groin fields at Miami Beach have had little positive effect in stabilizing the shorefront. The first of many was installed after the disastrous 1926 hurricane. Yet all the groins combined have not stemmed the outflow of sand, which continues at the average rate of 150,000 cubic yards each year. Today, several shorefront hotels have no berm remaining, and their hastily erected seawalls send ocean spray into parking lots and swimming pools.

Because groins rarely provide a long-term solution, they should not be considered a preferred method for sustaining a beach and berm. In the long run they are usually more expensive and less effective than well-planned programs of beach nourishment, a method that integrates the natural forces in operation along the coast.

On Fire Island, some communities tried to nourish their beach and berm with sand dredged from Great South Bay. Each attempt to restore the berm met with failure simply because the volume of sand involved was insufficient to maintain the *entire* berm. The littoral current redistributed this small amount of sand along the complete stretch of beach to the west.

The only way to maintain a beach and berm is to consider the entire oceanfront, from inlet to inlet, as a single system. On Fire Island, for example, sand quickly accumulates along the updrift side of jetties constructed for the purpose of keeping Moriches Inlet, at the east end, and Fire Island Inlet, at the west end, free of sand. A sand-transfer plant could pump sand through a buried pipe, less than three miles long, from the east side of Moriches Inlet and discharge it onto the downdrift side—on the east end of Fire Island—into the headwaters of the littoral current. There, the sand would re-enter the littoral conveyor belt and, as a berm-widening wedge, continue down the beach all the way to the inlet at Democrat Point, 30 miles to the west.

Furthermore, the sand building up along the east side of Fire Island Inlet could be pumped back east ten miles or so and discharged into the littoral stream, where it would be recycled westward, supplying additional sand to widen the berm and beach. To keep the navigation channels free of accumulating sand, Fire Island Inlet is now dredged periodically and the sand hauled several miles out to sea and dumped. Why such valuable sand is removed permanently from the littoral current is somewhat obscure, particularly since some of this sand has, at great expense, already been dredged out of Great South Bay and added to the beach and berm in front of the troubled communities to the east. The least that could be done with this excess sand would be to transfer it across Fire Island Inlet and feed it into the littoral stream along the heavily eroded east end of Jones-Oak Beach.

The best natural defense of a barrier island coast is a contin-

uously wide berm, and the least expensive way to achieve this is to rebuild and nourish it. In 1968, the Corps of Engineers authorized a beach nourishment project to redevelop and to maintain the shorefront of Miami Beach. With an initial investment of $30 million, the project would pump 15 million cubic yards of sand onto the entire ten miles of oceanfront between Government Cut and Bakers Haulover Inlet to produce a 2½-foot-high shelf, called a hurricane berm, that will extend about 20 feet beyond the present shoreline. From this berm, the beach will slope down to a new high-water line about 150 feet east of the present shoreline. Then, at an estimated expense of about $1 million each year, 200,000 cubic yards of sand will be dredged annually to nourish and maintain the 10-mile beach. Most of the sand will be obtained from the inlets, which will be kept free from sand accumulation. Wave action and the littoral currents would redistribute the sand along the entire shorefront.

If barriers such as Miami Beach and Fire Island require such careful management for their continued existence, how did they develop? How did they gain their initial toehold against the sea? Several theories on the origin of barrier beaches have been proposed.

Chains of barrier islands form only along a gently sloping continental coast of mostly sand and gravel. Such a condition might result from either a gentle crustal uplift of the continental shelf or because of a fairly rapid rise in sea level across a gently sloping glacial outwash plain or broad river delta. One popular theory suggests that because of the shallowness of the water under these conditions, breakers develop several miles offshore and a low, submerged sandbar develops. Eventually the bar rises above sea level and becomes a barrier island.

One objection to this theory of barrier island formation is particularly critical. When simulating barrier island conditions in a wave tank, upward development of submerged bars always stops as the water level is reached. Wave wash over the top prevents further sand accumulation, and the submerged bar does not become an island. Furthermore, there are no barrier islands in an early formative stage of development in the world today.

Considerable evidence suggests that some chains of barrier islands resulted from the breaching of spits, or islands connected to the mainland. Sand for these barrier chains was obtained from major headlands containing unconsolidated materials. By means of the littoral current, the sand was transported along the coast as an ever lengthening spit. Sandy Hook on the New Jersey coast is an example of such a formation. Breaching of the spit during storms formed the isolated barriers in the chain.

The headlands at Montauk Point apparently provide most of the sediment for Long Island's chain; Southampton Beach is the residual spit, having been breached several times to form individual islands that have continued to lengthen westward and seaward with the continued addition of sediment eroded from the headland bluffs. The Montauk headland consists of a terminal moraine, a ridge of jumbled boulders, cobbles, gravel, and sand. This collection of debris was scraped away from southern New England by glacial erosion, carried across what is today Long Island Sound, and deposited when the vast ice sheet stopped there some 17,000 years ago. Meltwater streams carried sand and gravel beyond the edge of this glacier and laid this sediment down as a gently seaward-sloping outwash plain, which once extended many miles farther southeast. A postglacial rise in sea level flooded almost all of the outwash plain along the east end of Long Island. With the stabilization of sea level in the past 5,000 years, wave erosion has removed the outwash sands that formed the spit and barrier islands. Today the terminal moraine stands face to face with the sea. The continued erosion of the moraine was recognized as early as the eighteenth century when George Washington, in designing the Montauk Point lighthouse, ordered that it be built at least 400 feet back from the morainal bluffs so that it would stand for at least 200 years. Recent measurements show only about 100 feet remaining, and at the present rate of retreat, only 50 feet will separate the base of the lighthouse from the sea at its bicentennial in 1997.

Recently, samples of sand grain surfaces along 20 miles of shore, from Montauk Point to East Hampton, were collected and studied under an electron microscope. These studies demonstrate that eroded glacial till is the major sediment source for Long Island's barrier chain. When magnified 5,000 times, sand grains from the glacial deposits at the foot of the lighthouse show a characteristic series of conchoidal, arc-shaped, semiparallel steps with considerable relief. These appear only on the surfaces of glacially transported sands. They do not occur on wave-moved sands or windblown dune sands west of East Hampton. Beach sands contain a number of V- or pyramid-shaped patterns, apparently indentations formed when the grains collide with each other in the littoral current. If the source is the glacial sand at Montauk Point, the beach pattern would be expected to become superimposed onto the glacial pattern; sand grains west of Montauk Point do show progressively fewer arc-shaped steps of high relief and more V-shaped patterns. Twenty miles west of Montauk Point the glacial pattern is replaced by the distinct V-shaped beach pattern.

After all the coastal surveys have been completed and detailed observations and measurements taken to indicate the source of sand, the volume of loss in one place and gain in another; after wave-tank demonstrations have shown clearly the underwater effects of high or low waves, of rapid-approaching or

Sand builds up on the west side of Westhampton Beach, at bottom, and spills into Moriches Inlet and the lagoon at right. By pumping it across the inlet, the sand could be fed into the westward moving littoral current for the beaches of Fire Island, at top.

slow-approaching waves, man still cannot alter the basic natural patterns between land and sea. For thousands of miles across the open sea, energy stored from distant storms will be transmitted in never-ending patterns of undulating swells and troughs. On nearing the coast, this energy will be transformed into steepened waves hurling thunderous breakers in one final, furious assault. And the land will continue to shift, either straightening its front to offer the least possible area for attack, or outmaneuvering the sea by redeploying material to an underwater position on which the waves must trip and sap their energies.

If man wishes to build his works on the fringes of such a battleground, he must understand that the rules of this ancient battle require the beach, the berm, and the dunes to shift constantly before the assault of the sea. If man tries to change these rules, he can only fail; and in his failure he may even undermine the fragile hold of these outposts against the powerful sea.

NORTHWEST PASSAGE

No supertankers, no radios, no hoopla — just a man

by Bob Skovbo

Photographs by Paul von Baich

Great Slave, Great Bear, Dogrib Country, the Northwest Territories—whatever images one associates with these names, I expect a distinct bleakness distinguishes them all. Barren and windswept tracts, icebound shores, stunted forests, lichen-crusted rocks, sinister bogs, chewed moccasins in abandoned cabins, nine months of snow and three months of mosquitoes: in short, no place to venture lightly; in fact, best perhaps to avoid.

This view is not entirely unfounded. Dogrib Country does look bleak on occasion, and can be an inhospitable place to be caught in. But this is largely a lopsided view, based mainly on tales of how some people *did* get caught there—these days commonly by crashing a plane provisioned with such survival items as several bottles of pop, some crackers and candy bars, and a change of nylon anklets for extra comfort. An acquaintance with the "howling wilderness" on these terms may make a good story, but it rarely makes a pleasant one. Since, however, good stories make better copy than merely pleasant ones, it is generally some such tale of disaster that reaches the public and helps to create a picture of the Northwest Territories as a place of grim and unrelieved desolation.

But there are other ways of getting acquainted with that country. The one I favor is by pack and paddle, and the view one then gains of its nature is quite different. The sense of awe it evokes may not be lost, indeed may be enhanced; but it is not a sense of the fearsome, the *awful*, but rather of the *awe-inspiring*. Boundless to your eye and indifferent to your puny presence, the country proves to be a land where you can travel and live with little hardship and much reward, in a setting whose beauty and interest are both inexhaustible and of a kind increasingly difficult to find elsewhere on our crowded planet.

As an introduction to this aspect of the Territories—nature in its pristine state—no region serves better than the interlake country between Great Slave and Great Bear, the ancestral territory of the Dogrib Indian. Virtually undeveloped save for a few small, but conveniently spaced settlements, it is still easily accessible and easily traveled. Furthermore, it is rich in splendid and varied scenery fascinating to both naturalist and student of man and of the proper proportions for a first trip through a true wilderness. Its 300-odd miles can be negotiated without undue hurry in three weeks to a month, just about the time a load of provisions can be made to last without having to strain one's back, tighten one's belt, or resort to supplements other than fish and perhaps an occasional waterfowl. The country abounds in fish, especially whitefish, lake trout, and pike, with pickerel and grayling occurring in places. Despite its shortness and other advantages, the route was unknown until 1900, and to this day remains little traveled in summer.

Because of a misadventure that befell me on my first attempt I have made the trip twice. My intention had been to make the interlake traverse to Great Bear merely the first lap of a journey to the Arctic Ocean, but instead I capsized on a lake in a flat calm and spent two weeks marooned on an island, until I was rescued by a canoeing party that happened to pass that way. I joined it as far as Great Bear and spent the rest of the season along the shores of that prodigious lake. The following year I tried again with more success, this time making sure to have some fellow enthusiasts along in order to extricate me more promptly from similar contingencies. But I can't say I regret either capsizing or having had to repeat the first lap. As a castaway I was no doubt exceptionally lucky, for I lost little equipment other than kayak and gun. Living on fish and a fair stock of provisions, I spent two of the most memorable and idyllic weeks of my life on that little island. And as for doing the

same stretch twice over, I wouldn't mind doing it a third time. Such is the appeal of that magnificent land.

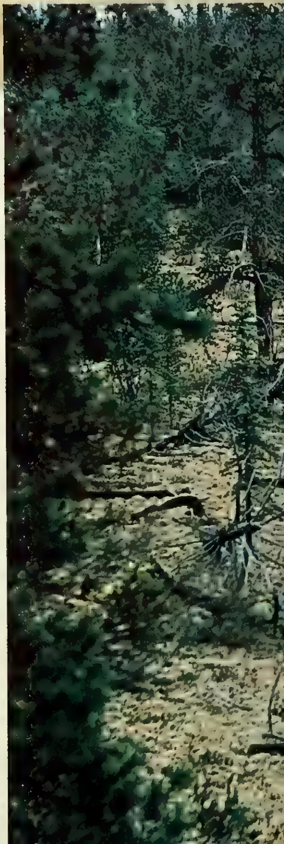
The accompanying photographs were taken on the second trip by my habitual companion Paul von Baich. We took a canoe rather than a kayak, mainly because we felt a canoe was more in style in the woods, but either craft is suitable for the trip.

We set out from Fort Rae in early June, with the ice. For anyone interested in the birdlife and botany of the country this is the most rewarding time to travel, and it is also the most enjoyable. Fort Rae is a Dogrib village squatting on an outcrop by Marian Lake, an extension of the north arm of Great Slave. Being shallow, it opens up well before the great lake, and a shore lead is all you require. The long hours of light, its brilliance on the ice and water, the blend of ice chill and hot sun, the arrival of birds in full voice and gorgeous plumage, the leaves opening and first flowers bursting into bloom—all these conspire to create a sense of renewal and exhilaration no other season can quite match. The weather, too, tends to be best at this time. Nor are you likely to get windbound for long should it turn bad; there is so little water for waves to form. If you hit an open lake on a windy day, you travel at night when the wind drops. Last but not least, the mosquitoes haven't hatched yet. They will, of course, but by that time it is too late for regrets, and not far to the big lakes of the Camsell watershed where they are less of a nuisance. Because the ice lasts long on these lakes, its chill delays the advance of the season, so you tend to travel through a perpetual spring right up to Great Bear.

The Marian River flows into Marian Lake. Ascending the river is the hardest part of the trip. The current can be quite strong at this time; it has many more rapids than are marked on the map; the portages aren't marked at all; and some are well concealed. But it is a delightful river, remarkable for the lushness of vegetation along sections of its lower course, where you will find spring in its first full flush: tall birch groves clad in feathery green; horsetails, mare's tails, rushes, and pond lilies pushing up from the river bottom; peculiar diked bayous lined with alder and willow, on whose still waters gleam the resplendent drakes of mallard, pintail, widgeon, scaup, and bufflehead. Northern sparrows—fox, Lincoln's, white-crowned, and white-throated—warble from waterline thickets, while from spruce tops backriver ring the chimes of the hermit and olive-backed thrush. Here, too, I once saw a flock of the rare Sabine's gull skimming after mayflies above a shallow lake, in no obvious hurry to reach their breeding grounds in the Arctic. No doubt they got there in time, though; it was I who didn't make it on that occasion. The huge yellow-billed loon is another migrant occasionally encountered on its way north, as are swans, several small waders, the odd jaeger, and above all, the merry old squaw ducks, whose loud voices and courtship antics invariably enliven the ice fringe of the melting lakes.

If I have stressed the more lush and verdant aspects of the country as it appears from the river, it is because of their unexpectedness at this latitude (and longitude) rather than their preponderance in the biome. In this area along the lower Marian, the bare rocky heights jutting above the skyline are just as characteristic a feature of the view, and a sortie away from the river reveals the typical boreal taiga spreading everywhere over lowlands and hollows. On the portage trail, the polygons of frost-cracked earth remind the traveler of the rigor of the climate, and as he proceeds toward higher land, the tall barren outcrops become increasingly prominent. By the time he reaches Mazenod Lake—where I spent my days as a castaway—they dominate the topography. Rarely rising more

"Of all these marks of man, only the gaunt frames of abandoned villages and the little woodland cemeteries, their crosses and fenced graves half-hidden in the tall grass, have achieved a harmony with their setting."



than 300 to 500 feet above the level of the land, their massive bareness bulks out of all proportion to their actual height. Geologically, they represent glacier-scoured mountain roots of the Canadian Shield, here folded into exceptional prominence as the shield thrusts against the Paleozoic formations to the west. This provides another fascinating feature of the route: it skirts the contact line between the major geologic formations of the subcontinent, the igneous shield and the western sedimentaries. All the major lakes are bounded on the east by the domed bastions of the Archean granites and gneisses, while to the west stretch the immense, calm contours of the Paleozoic formations deposited in Ordovician seas.

Not inappropriately, perhaps, the history of man is little evident against this prodigious backdrop. It seems a mere footnote to the bold writ of the land itself, and only emerged from prehistory a mere century ago, when the explorer-priest Emile Petitot first penetrated the area by dogsled in winter. He traveled somewhat to the west of the Marian-Camsell route. That waterway itself was not discovered until the year 1900, by the geologists Bell and Camsell. By the headwaters of the Camsell lies the little Dogrib village of Rae Lakes, a pleasant but somewhat saddening relic of a doomed way of life. Without government-built cabins and airlifted staples, it would hardly survive. Since the 1930's, periodic flurries of prospecting and mining have left an imprint here and there—abandoned mines at Hottah and Beaverlodge lakes, a wrecked Bristol aircraft inhabited by swallows, a pulley chain rusting by the river, trail blazes slowly healing at the foot of a portage. Lately, two mines have opened along the lower Camsell just before Conjuror Bay,

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but rather of the *awe-inspiring.*
Boundless to your eye and indifferent
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and a winter tractor road serving Echo Bay Mines at Great Bear intersects the canoe route at several points. This mine, incidentally, is the successor to Eldorado, which furnished the uranium for the first atomic bombs. The mine itself lies well off the route; the wide swath of the winter road is all that may remind the traveler of this fateful link with the outside world. And he may well find himself occupied with less momentous but more immediate concerns—such as abruptly vanishing into a bottomless bog. This nearly happened to me once; the winter road offers the most treacherous footing of the entire route. In places it melts into a livid, pinkish mush, known (to us) as "loon puke," afloat above a floor of ice that has a way of suddenly caving in. It seems instructive to reflect that the most dangerous place to walk in that country should be a man-made trail.

Of all these marks of man, only the gaunt frames of abandoned villages and the little woodland cemeteries, their crosses and fenced graves half-hidden in the tall grass, have achieved a harmony with their setting. Most strike the traveler as scars on the face of the land.

But as yet this impression is little more than a question of sensibility. The price that progress has exacted still seems small when measured against the enormous span of untouched nature. Nor can it be denied that an epic and melancholy beauty often haunts these tokens of our spasmodic efforts to wrest wealth from an indifferent land. Indeed I must confess that, traveling alone, I have sometimes welcomed the sight of something as unepic as an empty sardine tin. One may go there to learn about virgin nature, but it can become a rather lonesome quest, and a few oil cans or sardine tins can be an oddly heartwarming discovery. That some scraps of human refuse are able to call forth such sentiments in an age where elsewhere they threaten to imperil our very condition of life, perhaps demonstrates most convincingly the primeval state of this country.

It is always easy to forget the tin cans and scars in the ground and return one's attention to the things and beings that have their home here. The bald eagles—the day is rare that you don't see one beat and soar above the lakes; the vigor of a cold gray trout flapping in your grip; a moose turning its head as you paddle past; the vast mosquito-ridden muskegs afroth with the bloom of Labrador tea; the blue silence ringing with wings as scoters lift from the lake; the yell of the loon; its soundless plunge into the depth over which your boat moves toward another horizon. As you proceed north, two smaller loons appear, along with the common: the red-throated and the superbly elegant Arctic, with its pearl gray nape and weird voice. Incidentally, and contrary to its reputation in this regard, loon makes excellent eating, at least when attacked with the appetite that inevitably develops on such a trip. I mention this as a hint to anyone low on provisions; otherwise you are not supposed to molest them, of course.

As you cross into the Camsell watershed you have reached the hin-

terlands of Great Bear. It is here that the country unfolds in its full grandeur. It is a land of rock—rock scoured and planed and fractured, veined and warped, upthrust into domed heights, leveled to ramps and platforms, loosened into rockslides, broken and piled up on the shores or into bizarre islands of gigantic rubble, which appear to have erupted from the lake bottom. Yet the boreal forest of spruce (black and white), birch (canoe and dwarf), and a scattering of poplar (aspen and balsam), with its underbrush of currants and soapberry, continues to thrive wherever roots can find lodgment and drainage is adequate. Only the jackpine is missing; its last stands are seen a little north of Rae Lakes village. Flowers grow in profusion: arnica, cinquefoils (especially *Potentilla fruticosa*), and saxifrages (*Saxifraga tricuspidata*) seem to be by far the commonest species; *Parnassia palustris*; the minute lavender primrose *Primula incana*; the secretive, insectivorous butterwort; several kinds of Indian paintbrush; vetches; chickweeds; and willow herb—these in particular brighten the shorelines. Roses abound, and in the forest shade the shinleaf sprouts, while the exquisite rock-harlequin (*Corydalis*) grows on outcrops exposed to wind and sun. The profusion is greatest in bogs: ledums, andromeda, rosebay, cloudberry, and the bog cotton are the most conspicuous representatives of this flora. The only flower I had hoped to find north of the Marian River, and didn't, was the orchid *Calypso bulbosa*.

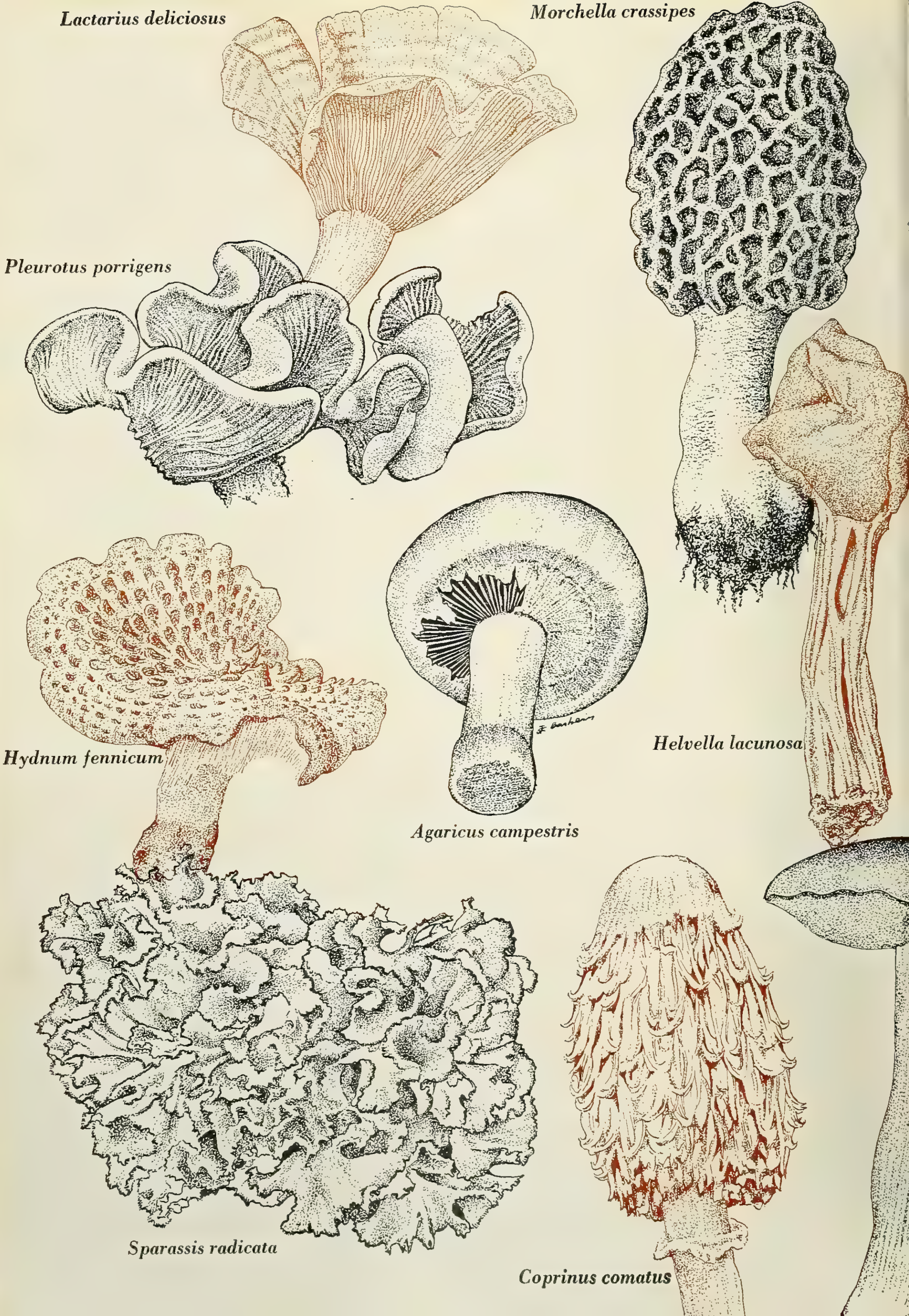
Unfortunately I am no botanist; no doubt this indiscriminate list of showy species merely reflects my enthusiastic ignorance of the subject. On the distribution of birds, however, I was able to make some more pertinent observations. Here the Marian/Camsell divide seems to roughly coincide with some range boundaries. Thus the last nighthawk and white-throated sparrow were seen both at the divide and just south of it, whereas the Lapland longspur, the tree sparrow, and the gray-cheeked thrush did not appear before the upper Camsell. The bittern, on the other hand, as well as the eastern kingbird, olive-sided flycatcher, black tern, and shoveler were not encountered above the lower Marian, and the song sparrow and the Caspian tern not beyond Marian Lake. The Caspian tern colony at the head of that lake, incidentally, appears to be the most northerly known nesting site for the species on this continent. It had not been previously reported, which illustrates how easily a small contribution to zoogeography can be made in these parts.

Of mammals one sees relatively few. The muskrat is common, beaver occur off and on, mink and otter, more rarely. Neither foxes nor lynxes were reported plentiful by the Indians, and martens and wolverines are rare. I never saw a wolf in the region, although tracks were common. In summer, the caribous are out in the barrens. Moose are invariably encountered en route, although the population is anything but dense. I saw but one bear during the time I spent in the country—that one I not only saw, but felt, too. As I slept in the tent, he woke me up by patting the tentcloth just off my left ear. Others have been luckier in sighting bears, though. These are all black, grizzlies seem confined to the country north and east of Great Bear.

As the season wears on and you pass through the austere approaches to Great Bear—Hottah, Grouard, Conjuror Bay—birdlife is no longer as evident. Fewer voices are heard, the silent spells grow longer. Spring is slowly turning into summer, even though the ice still holds out on the open reaches of Hottah Lake.

Often, while sitting on some outcrop smoking your pipe, the land seems empty as you survey its immense spread. A distant gull, some ringlets thrown up by a fish, a few mosquitoes. Sometimes nothing at all. But you don't mind. For it is not the emptiness of a void that encircles you, but a presence, a vastness, a quiet assurance that there is still room on earth. Not room to invade and occupy, but just room—inviolate and vast enough to harbor untold forms of life, as well as this calm inherited from an age before any life existed. For there is life in that lichen, too, on that rock by your boot. You learn to sense this, perhaps because of the calm. In a land so quiet and immutable, the smallest, slowest event, such as a lichen growing, seems almost to impinge on awareness. So also with the slim, dark spruce crowding the folds of the land, the horsetails and sedges at the waterline, the waves lapping, the clouds. No wonder then that one northern sparrow's warble can flood that silence to the rim and proclaim life more purely than the roar of an entire city.

“Often, while sitting on some outcrop smoking your pipe, the land seems empty as you survey its immense spread.”


Lactarius deliciosus
Morchella crassipes
Pleurotus porrigens
Helvella lacunosa
Hydnum fennicum
Agaricus campestris
Sparassis radicata
Coprinus comatus

MUSHROOMS

A brief guide to the tricky business of knowing which ones you can eat

by Peggy Young

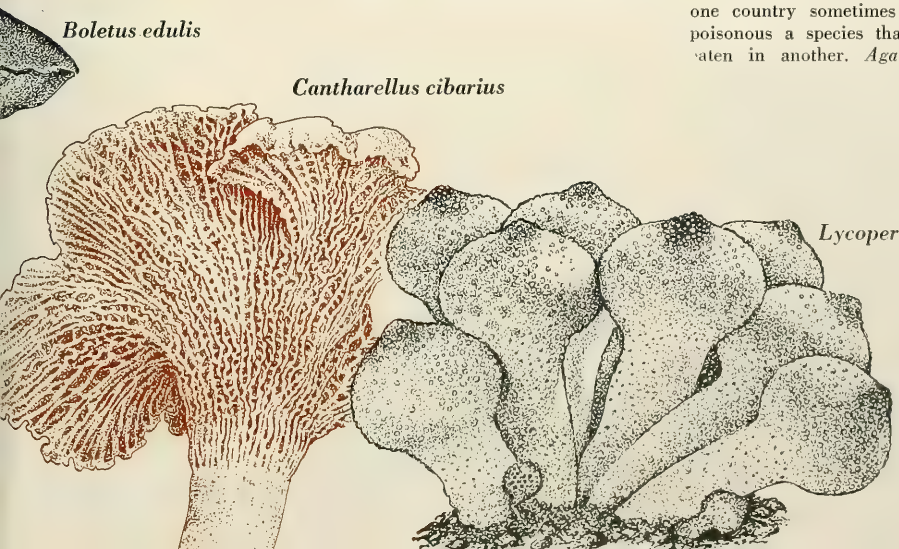
Several botanists know and often tell the tragic story of Family X. Having just emigrated from a country in middle Europe to Rockland County, a suburb some 12 miles north of New York City, Family X undertook a mushroom hike one bright Saturday morning. They scoured a nearby forest, and in a few short hours they had gathered enough mushrooms to provide a handsome lunch. They went home and in their huge black frying pan, they sautéed the mushrooms in butter and then ate them, evidently with great relish. What they did not finish they fed to Sally, their large calico cat. Within ten minutes, Sally suddenly began convulsing and Family X, horrified, rushed themselves to the local hospital. Their stomachs were pumped, emetics and tonics were administered, and Family X, after much uncertainty and discomfort, miraculously pulled through. Following their release from the hospital, Family X went home and there, nestled in a pile of sweaters on the top shelf of the linen closet, lay Sally, blissful as can be. She had given birth to seven kittens. Family X had misjudged a symptom.

The ancient Romans called mushrooms *cibus diorum*, "food of the gods." The Greeks ate them, too, and even earlier the Chaldeans assigned names to some of their species.

We call them mushrooms, toadstools, or fungi. In fact they are all fungi, but a certain amount of confusion surrounds the terms *mushroom* and *toadstool*. Some people use the word *mushroom* to designate all edible fungi, and refer to the poisonous species as toadstools. Others say that the meadow mushroom, *Agaricus campestris*, is the only mushroom and that all others are toadstools. A third group calls any fungus a toadstool if it grows elsewhere than under commercial cultivation. For the sake of clarity it is best to drop the word *toadstool* altogether and refer instead to edible or poisonous mushrooms.

Many species of mushrooms are not only edible but delectable; many more can be eaten safely by some people but not by others; and a few species are lethal. There is only one way to tell the good from the bad, and that is to learn to recognize the different species beyond all possible doubt. Various so-called tests for discriminating among mushrooms have circulated in the past. Mushrooms have been said to be edible if they peel easily, or poisonous if they tarnish silver or turn milk sour, and so on, but the truth is that none of these tests has any validity. The only way to know if a mushroom is edible is to recognize it in the same way that you recognize a blackberry or a strawberry. It takes a certain amount of time and study, but if you are going to eat wild mushrooms, it is necessary. There are no short cuts.

In Europe wild mushrooms have long been popular, but the people of one country sometimes regard as poisonous a species that is freely eaten in another. *Agaricus cam-*



pestris, for example, is considered poisonous in certain parts of France. Most Finnish people will not touch any mushrooms at all. In many European countries wild mushrooms are sold fresh in the markets, and several species, including the king boletus and the chantarelle (*Boletus edulis* and *Cantharellus cibarius*) are harvested and then dried or canned for export.

The most highly prized, perhaps, of all edible mushrooms are morels (*Morchella*) and truffles (*Tuber*). Morels appear in the spring and are found in both Europe and North America, growing in open woods, along roadsides, and in partially shaded meadowland. Truffles are native to Europe, and grow chiefly in France and the Piedmont section of Italy. They grow under deciduous trees, usually oaks, a foot or more beneath the surface of the ground; pigs and specially trained dogs are used to detect them.

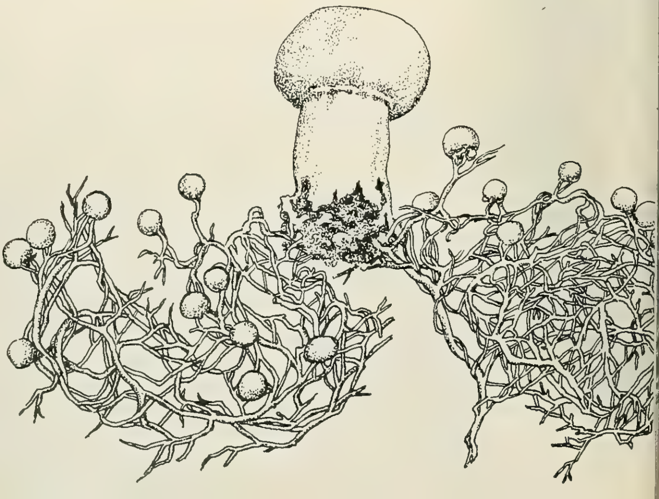
The commercial cultivation of mushrooms began in France during the reign of Louis XIV, and today there are mushroom beds in tunnels and caves stretching for miles under the streets of Paris and its suburbs. On this continent the greatest mushroom-growing area is in Pennsylvania, where half the country's annual 130-million-pound crop is raised. Near Pittsburgh the largest mushroom farm in the world produces 10 million pounds yearly in an abandoned limestone mine. Underground operation makes possible complete control of such vital factors as temperature, humidity, and ventilation. Almost the only mushroom grown commercially in North America and Europe is *Agaricus bisporus.* In Southeast Asia the preferred species is the paddy-straw mushroom, *Volvaria volvacea*, and in the Far East it is the Shiitake mushroom, *Lentinus edodes*, which is raised commercially on logs.

Although mushrooms have been eaten for hundreds of years, it is only recently that they have been recognized as plants. Before the nineteenth century, the poisonous qualities of some mushrooms, their association with decay, and their habit of apparently springing up overnight, out of nowhere, caused them to be thought of as mysterious entities belonging, not to the plant world, but to a separate world of their own. Superstition and folklore surrounded them; mushrooms were an important ingredient in the witches' brews of medieval England. Today mushrooms are under study by drug companies as a source of antibiotics, especially antitumor substances, and in the case of Mexican hallucinogenic mushrooms (*Psilocybe*), as a source of tranquilizing drugs.

Mushrooms do differ from most other plants in that they contain no chlorophyll, cannot carry on the food-making process of photosynthesis, and depend for their nourishment on the organic matter that has been manufactured by green plants from inorganic compounds. Most mushrooms live on decaying vegetable or animal matter, although a few are parasitic on living plants.

The life of the mushroom begins with the spore, which leaves the parent plant and drifts away on air currents. It has been estimated that a single mushroom can produce more than a billion spores. Most of these perish, but here and there one spore comes to rest where conditions meet its exacting requirements for growth. The spore germinates and produces threadlike structures, hyphae, which grow and branch out in all directions, penetrating the surrounding environment. Enzymes secreted by the hyphae digest some of the organic matter with which they come in contact, converting it into a form that the plant can absorb. The mass of hyphae is known as the mycelium, or spawn. In time the mycelium sends up fruiting bodies, frequently in the familiar umbrella shape; when these mature and release their spores the life cycle of the mushroom is complete.

Mushrooms vary greatly in the environmental conditions they need for growth. Some species, such as *Agaricus campestris,* flourish only in open meadows. Others, like *Pleurotus porrigens,* or angel wings, will grow only on rotting conifer logs. Still others grow among fallen leaves, in moss, on manure, or in other specific locations. Some species grow only among the rootlets of certain trees, forming fungus roots, or mycorrhiza. The association between a fungus and another living plant is sometimes necessary for the existence of both: orchids, for instance, need certain fungi, as does the Indian pipe of northern forests. The exact relationship between tree and fungus in mycorrhiza is not understood.



Geography plays its part in habitat, too, and some species of mushrooms are found in one section of the country but not in another, even though the ecology of both regions appears to be similar.

Moisture, light, and temperature have a great deal to do with the aboveground appearance or nonappearance of mushrooms. Once the mycelium is established it can live on in the same place as long as there is nourishment for it, but the production of fruiting bodies depends upon variations in temperature, rainfall, and probably other factors not yet recognized. The longevity of the mycelium is dramatically illustrated by the fairy rings sometimes found in grassy plains. The spot where the spore fell is the center of the ring; from there the hyphae spread out to form a circular mass with mushrooms growing up around its rim. In time the mycelium at the center dies, but it continues to expand at the perimeter at the rate of about thirteen inches a year, with fruiting bodies coming up in an ever widening circle. In Colorado and southern England there are fairy rings estimated to be more than four hundred years old.

Sometimes a mushroom species that has appeared regularly for a long time in one locality will vanish, and then, after ten years or more, return. Possibly the weather was unfavorable at certain critical stages of its life. One of the fascinating aspects of mushroom hunting is that you can visit the same spot year after year and find something different each time.

Most mushrooms we see belong to the Basidiomycetes division of fungi, and among these the Agaricaceae, or agarics, form the largest group. The agarics bear their spores on a series of gills, or plates, which radiate from the stem like the spokes of a wheel and are attached by their upper edges to the underside of the mushroom cap. Two other groups, the Boletaceae and the Polyporaceae (boletes and polypores) have pores and tubes instead of gills. The Hydnaceae, or hydnums, have a layer of downward-pointing teeth, and in the Clavariaceae, or coral fungi, the spores are produced all over the surface of the branched, coral-like fruiting body.

The division of fungi known as Ascomycetes, or sac fungi, differs from the division Basidiomycetes mainly in certain microscopic features having to do with the means by which sexual spores are produced. The morels belong to this division; they can be recognized by their hollow, elongated caps covered with deep, irregular pits. Other sac fungi are cup-shaped, like the orange fairy cup (*Aleuria aurantia*); or wrinkled and convoluted, like the brain mushroom (*Gyromitra esculenta*) and the elf saddle (*Helvella lacunosa*). Although such sac fungi as the morel and truffle are highly prized by gourmets, it is among the gilled agarics that most of the edible species are found, as well as most of the poisonous ones.

The typical gilled mushroom begins as a tiny globular form enclosed in what is known as a universal veil, or volva. Then, as the mushroom grows, the veil splits and either remains as a cup around the base of the stem and in patches on the cap, or disappears. Certain species have a second membrane, the partial veil, or annulus, stretching from the stem to the edge of the cap. As the cap expands, this veil tears, either at the cap edge or at the stem; it may remain on the stem in the form of a ring, or it, too, may disappear. The presence or absence of a cup or ring is a great help in identifying any mushroom.

Another important feature in identification is the color of the spores. In most instances the spore color will fall into one of five categories: white to creamy, pink to flesh color, rusty brown, purple-brown, or black. To determine their color, it is necessary to make a spore print; this is done by placing the mushroom cap, gill-side down, on a sheet of paper and covering it with a dish. Within a few hours a mass of spores will have fallen on to the paper to make a clearly discernible white or colored pattern. (White spores can be seen on white paper by holding the paper at an angle to a light source.)

A vital piece of equipment if you wish to hunt mushrooms is a notebook; memory can be unreliable, and notes made on the spot are invaluable. It is important to set down where and how the mushroom grows. Look for a ring on the stem or a cup around the base, and make certain that there is no cup hidden below the surface of the ground. Note the size and color of the cap, its shape, and texture.

Turn the mushroom over and look at the underside, noting whether the gills are free from the stem, broadly or narrowly joined to it, or running down it. In some species the gills are crowded closely together; in others they are far apart. They may be narrow or broad, of equal or of varying lengths; their color may be the same as that of the cap or different from it.

Examine the stem and note if it is thick or thin, long or short, tough or fragile, hollow or solid, or stuffed with a pithy core. In some species it is firmly attached to the

**thrusting mushroom,
aring spores, grows from
nching strands of
subterranean plant known
the mycelium. At an
rlier stage of development,
mushrooms look
e buttons.**

cap, in others it is easily broken off. In most species the stem is attached to the middle of the cap, but in some, it is off-center and in others, joined to the edge.

In a few mushrooms the flesh changes color when broken or bruised. Others exude a liquid—colorless, white, or colored—that may or may not change its hue with exposure to air.

After noting these features, wrap your mushroom carefully in waxed paper or a plastic bag (a separate wrapping should be used for each specimen), take it home and make a spore print.

With the foregoing clues to help you and a good mushroom guide in hand, you may possibly be able to identify your find. Possibly, but not necessarily. No one book covers all the several thousand species of mushrooms in North America, and you could easily have collected a species omitted from the book or books at your disposal. Many species can be positively identified only by their microscopic characteristics. It is advisable never to try to force your specimen to fit into a species if it differs in the slightest degree from the published description. If you are gathering mushrooms for the table, a mistake could be disastrous.

That some mushrooms are perfectly safe for one person, but not for another probably accounts for the differences of opinion among the authorities as to which species are edible and which are not. Some species of the genus *Coprinus* have been known to cause trouble only when eaten by people who have been drinking alcohol. When trying a new mushroom, be sure to obtain only young, fresh specimens, and restrict yourself to a very small portion, even if others have eaten it in quantity. You may be allergic to it.

The three basic types of mushroom poisons are the protoplasmic poisons, the nervous system poisons, and the gastrointestinal irritants. The protoplasmic poisons attack the heart, liver, kidneys, and skeletal muscles; symptoms appear suddenly after a delay of from eight to forty hours, and, in more than half the known cases, death is said to come within a few days. The nervous system poisons cause hallucinations and other symptoms, but are seldom fatal. The gastrointestinal irritants cause vomiting, cramps, and diarrhea, with recovery following fairly rapidly. Treatment for victims of poisoning is complicated because some mushroom species contain more than one poisonous substance. Furthermore, there is always the possibility of toxins not yet identified.

The greatest number of poisoning cases are caused by species of the *Amanita* genus. A few of the *Amanitas* are edible, but most are extremely toxic. Many are beautiful in appearance, large and brilliantly colored, with a frill-like ring on the stem, a cup at the base, and white, wartlike patches on the cap. But sometimes the ring is fragile and disappears, heavy rain washes the warts off the cap, or the cup is buried under ground debris. Not all *Amanitas* are brightly colored, and not all are recognizable on sight.

Amanita muscaria, the fly agaric, is a very common species with a cap that measures up to eight inches across. In North America the color ranges from bright scarlet in the west to orange or almost yellow in the east. It has been eaten in minute amounts (chiefly by the natives of Kamchatka in northern Russia) and is said to produce beautiful hallucinations and sensations of well-being, but the dosage is so critical that a fraction too much brings acute pain, destruction of tissues, and finally death. *Amanita pantherina*, found in the Northwest woods, has proved fatal to children who ate only a mouthful. Several of the white *Amanitas* are called "destroying angel," a name that speaks for itself.

While it is best to give all *Amanitas* a wide berth, it is not necessary to forgo all mushrooms for fear of encountering a poisonous one. Among the edible mushrooms of good flavor are a number that are easy to recognize. Any puffball can be eaten when it is young and still pure white inside, with no tinge of yellow and no holes indicating the presence of insect larvae. Cut the puffball in half lengthwise to make sure that it is not an *Amanita* still enveloped in its veil: the *Amanita* will exhibit a stem, cap, and gills; the puffball is homogenous in form. *Calvatia gigantea*, a puffball that grows to enormous size, is so tender that it can be eaten raw in salads. It is sometimes cut into half-inch slices and sautéed in butter, or it can be cooked like French fried potatoes.

Most of the mushrooms with pores instead of gills can be eaten, but avoid any that turn blue when cut, and any with red pore mouths. The king boletus, which can reach a size of ten inches across, belongs to the pore group. In Europe it goes under a number of names—cèpe (France), steinpilz (Germany), boroviki (Poland), stensopp (Denmark)—indicating its widespread popularity. The ancient Romans served the king boletus at banquets, using special dishes called "boletarii." In North America it grows in open woodlands from the Atlantic to the Pacific, and for the best flavor should be cooked the day it is picked.

The chantarelle was another favorite of the Romans. This delicious mushroom is a bright egg-yolk yellow in all its parts—cap, stem, and gills. The fruity flavor, somewhat like that of ripe apricots, is so delicate that, according to gourmets, the chantarelle should never be combined with other foods, but always served as a separate dish. It requires gentle cooking over low heat; overcooking or too hot a fire will cause it to shrivel and become tough. In appearance the chantarelle bears some resemblance to another mushroom, the orange clitocybe (*Clitocybe aurantia*), which is suspected of being poisonous to some degree. The *Clitocybe*, however, has a dry, tan-colored cap and bright orange gills; the resemblance is not marked enough to cause confusion once you have actually seen a chantarelle.

A familiar mushroom is the shaggy mane, *Coprinus comatus*, which grows along roadsides, in wasteland, in city gardens, and back lanes. Its tall, cylindrical cap, grayish white in color and covered with ragged scales, is unmistakable. It must be picked young and cooked at once, for if left for only a few hours the gills dissolve into an inky fluid. Oven cooking is best for the shaggy mane, as the caps are soft and fragile and tend to disintegrate unless handled carefully.

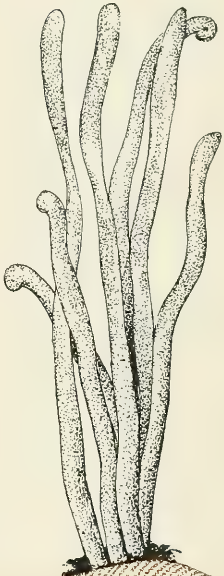
The cauliflower mushroom, *Sparassis radicata*, is another unmistakable species. It looks like a large, pale head of lettuce and grows under conifers; it is tough and strongly flavored, but very good in soups and gravies. Much milder in flavor are the angel wings that grow on fallen trees in the forest. These are white, fragile, and fanshaped; when dried and salted, they can be eaten raw.

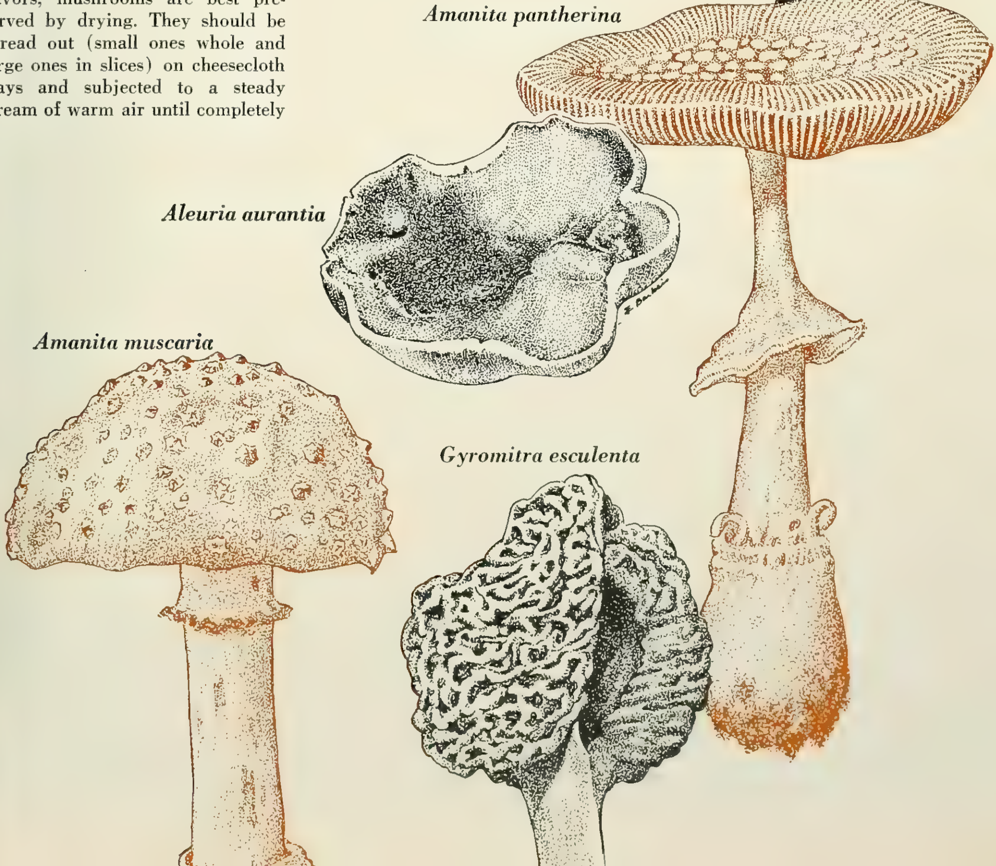
In order to retain their subtle flavors, mushrooms are best preserved by drying. They should be spread out (small ones whole and large ones in slices) on cheesecloth trays and subjected to a steady stream of warm air until completely dry and crisp, then stored in moistureproof jars. Before use they will require soaking—from one to three hours, depending on the thickness of the slices.

The food value of mushrooms compares favorably with that of most garden vegetables. It varies somewhat with the different species, but in general mushrooms are high in several of the B complex vitamins and vitamin C, and are a good source of iron and copper. They are moderately high in proteins and low in calories.

The nutritious, dangerous, and delicious mushroom is eaten by many animals other than man. In the wild, cattle, deer, squirrels, slugs, snails, and innumerable insects and insect larvae regularly partake of the "food of the gods."

Clavaria pulchra





Sky Reporter

Carbon Monoxide in Space Another chemical compound has been found in the "empty" reaches of interstellar space. A team of Bell Telephone Laboratories scientists, working at Kitt Peak in Arizona, has detected carbon monoxide in at least five radio sources, including one at the center of our galaxy.

The existence of hydrogen in space has been known for years, and radio astronomers have been able to map the heavier concentrations. Then last year ammonia, water, and formaldehyde molecules were detected for the first time. Now we can add carbon monoxide to the list—and wait to see what turns up next.

End of a Comet Most asteroids have very irregular shapes, a characteristic to be expected if they are indeed fragments left when larger bodies collided. But at least a few asteroids may be the final remains of comets that have lost their volatile components and can no longer produce tails.

The asteroid Icarus, which came within five million miles of the earth in 1968, is a case in point. Tom Gehrels, Elizabeth Roemer, R. C. Taylor, and B. H. Zellner of the Lunar and Planetary Laboratory in Tucson, writing in the *Astronomical Journal,* report that Icarus is a stony-metallic object, less than half a mile across, that rotates in two hours. It is nearly spherical, while asteroids typically are irregular. Brian G. Marsden of the Smithsonian Astrophysical Observatory points out in the same issue that the orbit of Icarus strongly resembles a comet: it sweeps in close to the sun, within 18 million miles, and then out beyond the earth in a highly eccentric orbit—most asteroids have more circular orbits. Finally, a meteor stream is associated with its orbit, as is the case with a number of comets.

How do you tell an asteroid from a comet? An asteroid presents the sharp, pointlike image of a star. A comet, on the other hand, looks diffuse. A solid nucleus is surrounded by a coma—a cloud of gas—boiled off the nucleus by the heat of the sun. When a comet comes close enough to the sun, the gases are pushed away by the solar wind and the sunlight itself, producing the characteristic comet tail. An object like Icarus experiences surface temperatures of some 2,000 degrees at its closest approach to the sun; it goes through this every 409 days, and presumably by now all its volatile elements have long since been lost. If, as is generally believed, comets are balls of frozen water and gases mixed with dust grains and pebbles, then when the last of these volatiles has evaporated, the remains may be compared to a flying gravel bank.

Halo Around Comet Bennett A scientific satellite has detected a cloud of hydrogen eight million miles across surrounding Comet Bennett, the morning-sky comet that reached first magnitude near the end of last March.

An orbiting geophysical observatory scanned the comet when it was about 65 million miles away in early April. It found a cloud of hydrogen, the most common element in the universe, ten times the size of the sun. The discovery was only the second of its kind: last January another satellite found a similar cloud around Comet Tago-Sato-Kosaka.

Galactic Explosions The explosions and ejections of large clouds of matter that we see going on in other galaxies apparently happened in our own as recently as ten million years ago. This is the suggestion of a Dutch radio astronomer who has been studying the motions of hydrogen clouds around the center of our galaxy.

We cannot optically see into the center because clouds of dust block the view. But radio waves can penetrate the dust, and radio telescopes on earth can pick up the emissions of hydrogen atoms near the galactic center, some 25,000 light-years away. The wavelength at which they are received indicates whether the source is moving toward or away from us, and how fast. P.C. van der Kruit used a radio telescope at Dwingeloo to refine our picture of the center.

He reported in *Astronomy and Astrophysics* that two clouds of hydrogen appear to have been ejected from opposite sides of the galactic nucleus at a large angle to the plane of the galactic disk, and that they may be falling back into the plane at some distance from the center. The quantity of matter involved is equal to about five million suns.

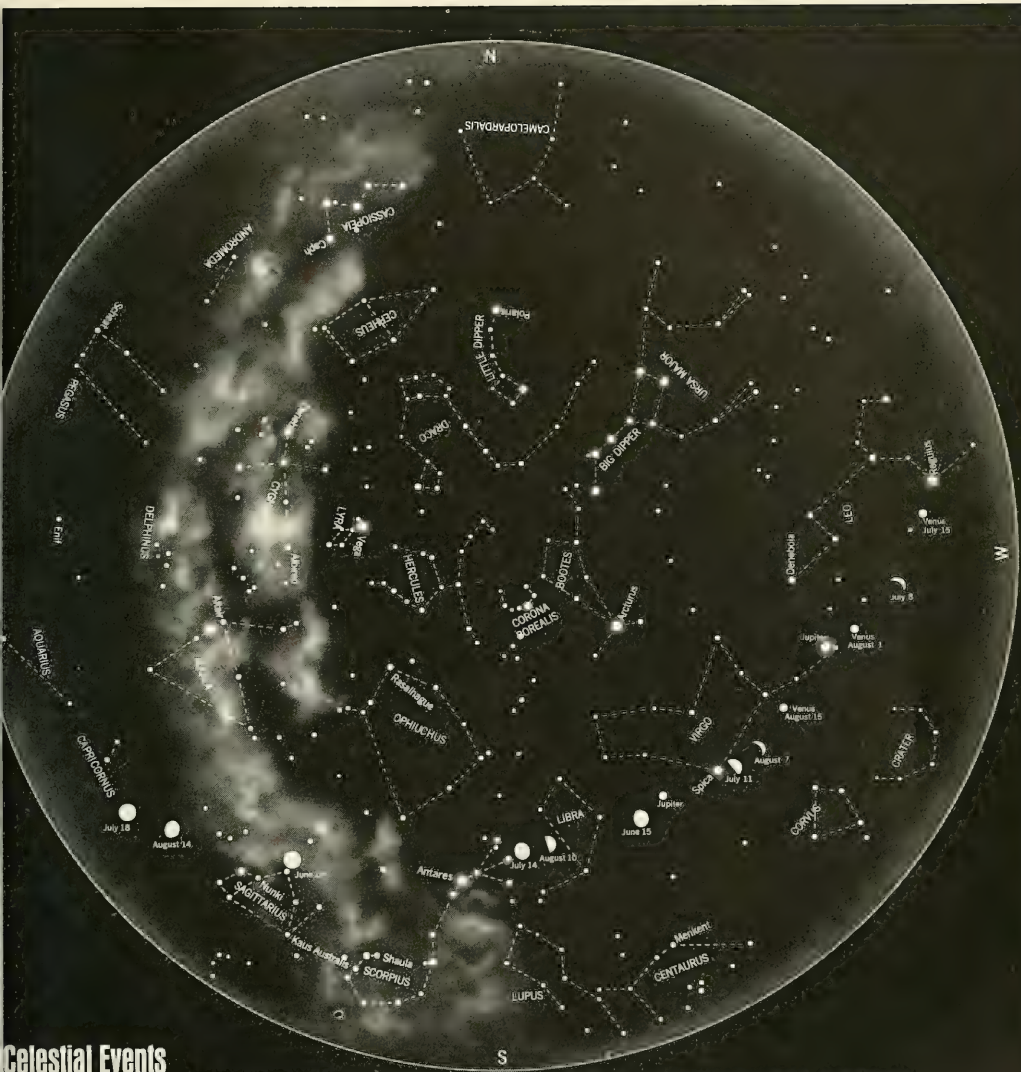
Van der Kruit also finds that two arms of hydrogen expanding out from the nucleus in the galactic plane may have received their impetus from the same or similar explosions, one tens of millions of years ago and one five to ten million years ago.

The ejected clouds appear to be larger, less dense, and longer-lived than those now seen being ejected from a class of galaxies with violent nuclei known as Seyfert galaxies. Van der Kruit suggests that the activity in our galaxy may represent a later stage of evolution.

Revising the Solar Constant A key number for any physical study of the whole earth is the quantity of radiation it receives from the sun. Even a small change could have large effects on the world's climate. Now scientists are finding, not that the sun is varying its output, but that their measurements have been a little off.

The accepted figure for the total radiation received, the solar constant, has been two calories per square centimeter per minute. It is a difficult number to determine because some types of radiation can be measured only above the earth's atmosphere. Now two groups, working with airplanes, rockets, balloons, and spacecraft, have found the total radiation reaching the earth is 3 percent less than had been thought: the solar constant should be 1.94 calories. The amount of visible light is 8 percent less. These are small differences, but small differences in very large forces can have large effects. We must know what the forces are to know what is happening, and what will happen.

JOHN P. WILEY, JR.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SAGITTARIUS
July 14
August 10
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Kaus Australis
Shaula
SCORPIUS
LUPUS
Menkent
CENTAURUS
S

Celestial Events

The moon is in the evening sky in mid-June, becomes full on the 19th, then reaches last-quarter on the 25th. In July, new moon is on the 3rd, first-quarter on the 11th, full moon on the 18th, and last-quarter on the 25th. New moon returns in August on the 2nd, first-quarter on the 10th.

Venus and Jupiter dominate the evening sky. Venus is very bright in the west during early evening twilight, becoming brighter and setting later during the summer. Jupiter appears high toward the south at dusk and sets about midnight or earlier. Saturn is a morning star.

June 17: The star near the moon is Antares, in Scorpius.

June 21: Summer begins at 2:43 P.M., EST, when the sun arrives at the summer solstice in Gemini.

July 4: Earth arrives at aphelion, where it is most distant from the sun, 94,514,000 miles away.

July 6-7: The crescent moon is near Venus on these evenings. The star nearby is Regulus, in Leo.

July 11: Venus and Regulus are in conjunction.

July 11-12: The moon is near Jupiter in the evening sky.

July 29: The relatively weak Delta Aquarid meteor shower, about 20 meteors per hour per observer, reaches maximum with moonless morning skies.

August 5-6: You can find Venus near the crescent moon on these evenings.

August 8: The crescent moon is near Jupiter.

August 12: One of the best meteor showers of the year, the Perseids, reaches maximum this morning with an hourly rate of 50 or more. With early moonset, observing conditions should be good for several mornings before and after the 12th.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:25 P.M. on June 15; 9:25 P.M. on July 1; 8:30 P.M. on July 15; and 7:20 P.M. on August 1; but it can be used for about an hour before and after the times listed.

The Star Dragon

Continued from page 26

him, flint would strike for him, vessels would carry him over dangerous waters.

In the end, with the naked body of an awkward and hastily readjusted climber, he would plumb the seas' depths and mount, with wings spun in his brain, the heights of air. Enormous computations upon the movements of far bodies in space would roll in seconds from his computers. His great machines would leap faster at his bidding than the slower speed of his own nerves.

Because of speech, drawn from an infinitesimal spark along a nerve end, the vague, ill-defined surroundings of the animal world would be transformed, named, and categorized. Mind would reach into a past before its becoming; the misty future experienced by dim animal instinct would leap into sudden, clear perspective. Language, whose constituents have come down the long traverse of millennia, as rolled and pounded by circumstance as a flint ax churned in a river bed, leaves no direct traces of its dim beginnings. With the first hieroglyph, oral tradition would become history. Out of a spoken sound, man's first and last source of inexhaustible power, would emerge the phantom world that the anthropologist prosaically calls culture. Its bridges, its towers, and its lightnings lie potential in a little globe of gray matter that can fade and blow away on any wind. The novelty of evolutionary progression through time has begotten another novelty, the novelty of history, the evolutionary flow of ideas in the heads of men.

About ourselves there always lingers a penumbral rainbow—what A. L. Kroeber termed the superorganic—that cloud of ideas, visions, institutions that hover about, indeed constitute human society, but which can be dissected from no single brain. This rainbow, which exists in all heads and dies with none, is the essential part of man. Through it he becomes what we call human, and not otherwise.

Man is a creature not to be contained in a solitary skull vault nor is he measurable as, say, a saber-toothed cat or a bison is measurable. Something, the rainbow dancing before his eyes, the word uttered by the cave fire at evening, eludes us and runs onward. It is gone when we come with our spades upon the cold ashes of the campfire four hundred thousand years removed.

Paradoxically, the purpose of the human brain is to escape physical specialization by the projections of thought. There is no parallel organism with which to compare ourselves. The creature from which we arose has perished. There is no twilight world of living fossils on the direct hominid line that we can subject to examination. At best we are forced to make inferences from less closely related primates whose

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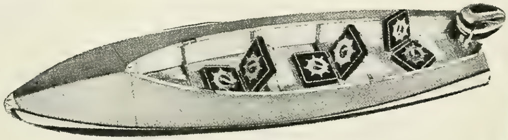

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activities lie below the threshold of speech.

The nineteenth century, through the efforts of men like Hughlings Jackson, came to see the brain as an organ whose primary parts had been laid down successively in evolutionary time, a little like the fossil strata in the earth itself. The centers of conscious thought were the last superficial deposit on the surface of a more ancient and instinctive brain. As the roots of our phylogenetic tree pierce deep into earth's past, so our human consciousness is similarly embedded in, and in part constructed of, pathways that were laid down before man in his present form existed. To acknowledge this fact is still to comprehend as little of the brain's true secrets as an individual might understand of the dawning of his own consciousness from a single egg cell.

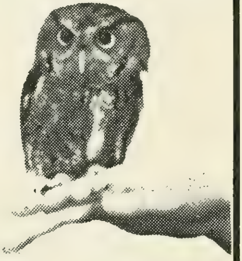
The long, slow turn of world-time as the geologist has known it, or the invisibly moving hour hand of evolution perceived only yesterday by the biologist, has given way in the human realm to a fantastically accelerated social evolution induced by industrial technology. So fast does this change progress that a growing child strives to master the institutional customs of a society that, compared with the pace of past history, compresses centuries of change into his lifetime. I myself, like others of my generation, was born in an age that has already perished. At my death I will look my last upon a nation that, save for some linguistic continuity, will seem increasingly alien and remote. It will be as though I peered upon my youth through misty centuries. I will not be merely old; I will be a genuine fossil embedded in onrushing man-made time before my actual death.

There never was a first man or a first primate," Dr. Glenn Jepsen of Princeton once remarked iconoclastically. The distinguished paleontologist then added that the "billions of genetic filaments in our ancestral phyletic cord are of many lengths, no two precisely the same. We have not had our oversized brain very long but the pendactyl pattern of our extremities originated deep in . . . the Paleozoic." It is now possible to add to Dr. Jepsen's observation that we have, of late, discovered that our bipedal, man-ape ancestors seem to have flourished for a surprisingly long time without any increase in their cranial content whatever—some four or five million years, in fact.

It used to be thought that the brain of protoman would have had to develop very early to enable him to survive upright on the ground at all. His bipedal pre-man phase lasted much longer—five or six times at least—than his whole archeological history down to this very moment. What makes the story so mystifying is that the expansion of man's neurocranium took place relatively rapidly during the million years or so of Ice Age time, and has not been traced beyond this point. The supposed weak-bodied creature whom Darwin nervously tried to fit into his conception of the war of nature on the continents has romped through a longer geological time period than his large-brained descendants may ever see.

We know that at least two million years ago the creature could make some simple use of stones and bones, and may possibly have fashioned crude windbreaks. He was still small-brained in human terms, however, and if his linguistic potentialities were increasing, there remains no satisfactory evidence of the fact. Thus we are confronted with the question why man, as we know him, arose, and why, having arisen, he found his way out of the green confines of his original world. Not all the human beings even of our existing species did. Their brains are comparable to our own, but they have lingered on, something less than one percent of today's populations, at the edge of a twilight world we have forgotten. There can thus be no ready assertion that man's departure from his first world, the world of chameleon-like shifts and forest changes, was either ordained or inevitable. Neither can it be said that visible tools created brains. Some of the forest peoples—though clever to adapt—survive with a paucity of technical equipment.

As to why our pygmoid ancestors or, more accurately, some group of



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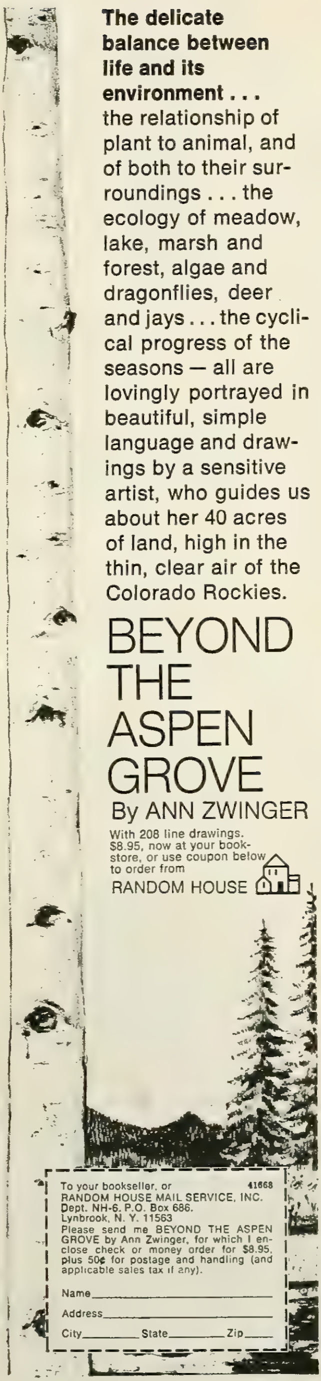

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them, took the road to larger brains we do not know. Most of the suggestions made would just as readily fit a number of nonhuman primate forms who did not develop large brains. Our line is gone, and while the behavior of our existing relatives is worth examination, we cannot ravel out of another genetic strand the complete story of our own.

Not without interest, however, is the fact that much of this development is correlated with the advances and recessions of the continental ice fields. It is conceivable, at least, that some part of the human stock was being exposed during this time to relentless genetic pressure under conditions of successive isolation and mixture. A few scattered finds from remote portions of the Euro-Asiatic land mass will never clarify this suspicion. For hundreds of thousands of years of crucial human history we have not a single bone as a document.

There is another curious thing about the Ice Age. Except for the emergence of genuinely modern man toward the close of its icy winter, it is an age of death, not a birthtime of species. Extinction has always followed life relentlessly through the long eras of earth's history. The Pleistocene above all else was a time of great extinctions. Many big animals perished, and though man's hunting technology was improving, his numbers were still modest. He did not then possess the capacity to ravage continents in the way he was later to do.

The dinosaurs vanished before man appeared on earth, and their disappearance has caused much debate. They died out over a period many millions of years in extent and at a time when the low, warm continents lapped by inland seas were giving way to bleaker highlands. The events of the Ice Age are markedly different. First of all, many big mammals—mammoth, mastodon, sloth, long-horned bison—survived the great ice sheets only to die at their close. It is true that man, by then dispersing over the continents, may have had something to do with their final extermination, but there perished also certain creatures like the dire wolves, in whom man could have taken little direct interest.

We are thus presented, in contrast to the situation at the close of the age of reptiles, with a narrowly demarcated line of a few thousand years in which a great variety of earth's northern fauna died out while man survived. Along with the growing desiccation in Southwest Asia, these extinctions gave man, the hunter, a mighty push outside his original game-filled Eden. He had to turn to plant domestication to survive, and plants, it just happens, are the primary road to a settled life and the basic supplies from which cities and civilizations arise. A half-dying green kingdom, one might say, forced man out of a relationship that might otherwise have persisted down to the present.

But, the question persists, why did so many creatures die in so little time after marching back and forth with the advancing or retreating ice through so many thousand years? Just recently the moon voyage has hinted at a possible clue, though it must be ventured very tentatively when man's observational stay upon the moon has been so short.

The Apollo 11 astronauts observed and succeeded in photographing melted or glazed droplets concentrated on points and edges of moon rock. Thomas Gold, director of Cornell University's Center for Radio Physics, has suggested that these glasslike concretions are evidence of melting produced by a giant solar flare persisting for only a few moments, but of an unexpected intensity. Giant storms are known to lick outward from the sun's surface, but a solar disturbance of the required magnitude to account for such a melting—if it was indeed sun-produced—would have seemed from earth like the flame of a dragon's breath. Most of the ultraviolet of the sun-storm, generated perhaps by a comet hurtling into the sun's surface, would have been absorbed by the earth's atmosphere. A temperature effect on earth need not have been pronounced so long as the flare was momentary. The unprotected surface of the moon, however, would have received the full impact of the dragon's tongue.

Gold has calculated by various means that the event, if actually produced by a solar flare, lies somewhere close to thirty thousand years from us in time and is therefore unrecorded in the annals of man. But here is the curious thing. The period involved lies in the closing Ice Age, in the narrow time zone of vast extinctions in the Northern Hemisphere. Was the giant flare, an unheard-of phenomenon, in some way involved with the long dying of certain of the great mammals that followed? Seemingly, the earth escaped visible damage because of its enveloping blanket of air. No living man knows what the flicking tongue of a dragon star might do, however, or what radiation impact or atmospheric change might have been precipitated upon the earth. Some scholars are loath to accept the solar flare version of the moon glaze because of the stupendous energy that would have had to be expended, and the general known stability of the sun. But men are short-lived, and solar catastrophes like the sunward disintegration of a comet would be exceedingly rare. Until more satisfactory evidence is at hand, most scientists will probably prefer to regard the glazed rock as splashed by the heat of meteoritic impact.

Nevertheless, the turbulent outpouring of even ordinary solar flares is on so gigantic a scale as to be terrifying in a close-up view. Until there is further evidence that ours is not a sleepy dragon star, one may wonder just what happened thirty thousand years ago, and why, among so many deaths, it was man who survived. Whatever occurred, whether by ice withdrawal or the momentary penetration of the ultraviolet into our atmosphere, man's world was changed. Perhaps there is something after all to the story of his eviction from the green Garden.

When I lie in bed now and await the hastening of Halley's comet, I would like to dream my way back to that single, precise instant when the star dragon thrust out its tongue. Perhaps the story of all dragons since comes from that moment. Men have long memories when the memories are clothed in myth. But I dream, and the train whistle mingles and howls with the heaven sweeping light in my dream. It is 1910. I am going back once more. ■

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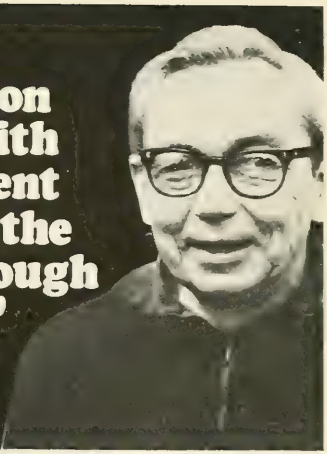

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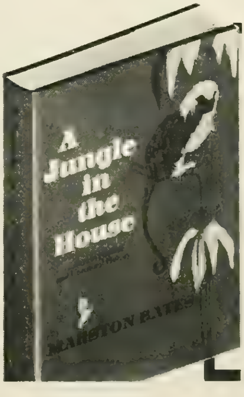

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Books in Review

The Indian in America's Closet

by Richard I. Ford

The Indian is in! Boutiques sell pseudo-Indian styles, hippies feed their spirits Indian fashion, while headline stories show Indians desperately claiming forlorn and forgotten Alcatraz Island. Magazine articles reveal that many of these so-called vanishing Americans, who live as government wards in needless poverty, are actually rapidly increasing in numbers. At the same time. the increased interest and concern for the Indian has not escaped the book publishers. As the bookstalls swell, baffled laymen often ask anthropologists, "Which of these books will tell me what I should know about Indians?"

My own library reflects these trends as they have accelerated in the past decade. but before I answer the question of which books are most informative, we need to explore the implications of this oft-repeated query. The American Indian was living here many thousands of years ago, built the colossal monuments. created the artwork. and told the beautiful stories that capture our imaginations today. Their descendants greeted first Columbus and later, preachers and politicians. who often only bore a Trojan horse. During the conquest of the West, it was more than evident that Indians actually belonged to different tribes with markedly different cultures. but this knowledge did not prevent people from forming degrading stereotypes of all Indians. Failing to exterminate the people. government agents then attempted to forcibly extinguish Indian cultures. This is no longer official policy, but it had an effect on the quality of anthropological and historical research—the very sources we turn to for answers to our questions—as well as on the attitudes of the Indians themselves.

Each of these episodes has been described by different specialists. For answers about the Indians' pre-Columbian past we must turn to archeologists. The Indians' initial contacts with European-derived cultures provide the grist for the ethnohistorian, while the ethnologist attempts to reconstruct various Indian cultures at a time before too much disruption occurred, known as the ethnographic present, or he attempts to study contemporary changes. This is by way of saying that the initial question of what books to read lacks a simple answer, that the selection must come from works designed to give us an understanding of American Indians from a variety of perspectives, including the point of view of the Indians themselves.

For those readers who desire a sensitive and accurate account of the effect of an alien culture on Indians. I particularly recommend four exquisitely written paperbacks. The first is *Ishi in Two Worlds*, by Theodora Kroeber. which records the life of the last Yahi Indian in California, who miraculously turned up at the end of the extermination period. The second is Thomas Berger's *Little Big Man*, which faithfully reflects many Indian attitudes. Another work that presents contemporary life is the humorous story, *Stay Away, Joe*, by Dan Cushman. The fourth book, *House Made of Dawn*, the 1969 Pulitzer Prize winning novel, is a fateful story about a Jemez Indian who symbolizes the lot of so many Indians. It was written by N. Scott Momaday, a Kiowa.

Few authors have tackled the difficult challenge of describing all aspects of the American Indian, from his prehistoric arrival in North America to the present. Although it includes South America, Alvin M. Josephy, Jr.'s *The Indian Heritage of America* is one extremely successful paperback. Another, which has infuriated many Indians because of its call for a Society for the Preservation of Cultures and which has angered anthropologists for molding facts into a particular evolutionary theory, but which, nevertheless, presents normally tedious information in a beautifully written way, is *Man's Rise to Civilization as Shown by the Indians of North America from Primeval Times to the Coming of the Industrial State*, by Peter Farb. Robert F. Spencer and his colleagues have compiled a readable and easily understood textbook on North American prehistory and ethnology entitled *The Native Americans.*

Recently, a number of books have joined Clark Wissler's *The American Indian* and Ruth Underhill's *Red Man's America* as summaries of tribes or cultural traits in the ethnographic present. *This Land Was Theirs*, by Wendall Oswalt, sketches

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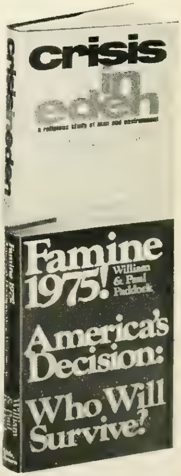
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past and present life in ten selected tribes. His book contrasts with Harold E. Driver's encyclopedic *Indians of North America,* which describes and maps distributions of such cultural traits as weaving and house types. Fred Eggan's *The American Indian* is a superb book recommended for the reader desiring a more technical analysis. Two excellent paperbacks, part of The American Museum Science Book series, that describe two culture areas are *Indians of the Plains,* by Robert Lowie, and *Indians of the Northwest Coast,* by Philip Drucker.

Anthropologists are most often asked for information about particular tribes. George P. Murdock's *Bibliography of North American Indians* provides a fine start. Two reprinted books, the threescore-year-old, but still useful, *Handbook of American Indians North of Mexico,* edited by Fredrick W. Hodge, and *The Indian Tribes of North America,* by John R. Swanton, contain much information, and it is regrettable they are not consulted more often.

A good, inexpensive account of the prehistory of the American Indian is still needed, and presently no book incorporates the most recent interpretations. Nevertheless, Gordon R. Willey's well-illustrated synthesis, *An Introduction to North American Archaeology,* is highly recommended. Another is *Prehistory of North America,* by Jesse D. Jennings, which is a good textbook but which, unfortunately, reads like one. An appreciation for the direction in which American Indian archeology is headed, which differs significantly from the presentations in the above books, can be found in the essays in *Anthropological Archeology in the Americas,* edited by Betty Meggers, and in *New Perspectives in Archeology,* edited by Sally R. and Lewis R. Binford. A word of warning, however: these are highly technical papers, which only an experienced reader will fully appreciate.

Anthropology is a young science, and anthropologists were not around when they should have been—at the time of contact. Consequently, for an appreciation of "pristine" life just beyond the frontier, we must rely on accounts like Joseph P. Donnelly's expensive but important *Wilderness Kingdom: The Journals and Paintings of Nicholas Point, S. J.,* or on summaries of other eyewitness observations abridged in another Harold E. Driver paperback, *The Americas on the Eve of Discovery.*

Indian artists have also provided us with insight into their own lives and tribes. Red Hawk's drawings were

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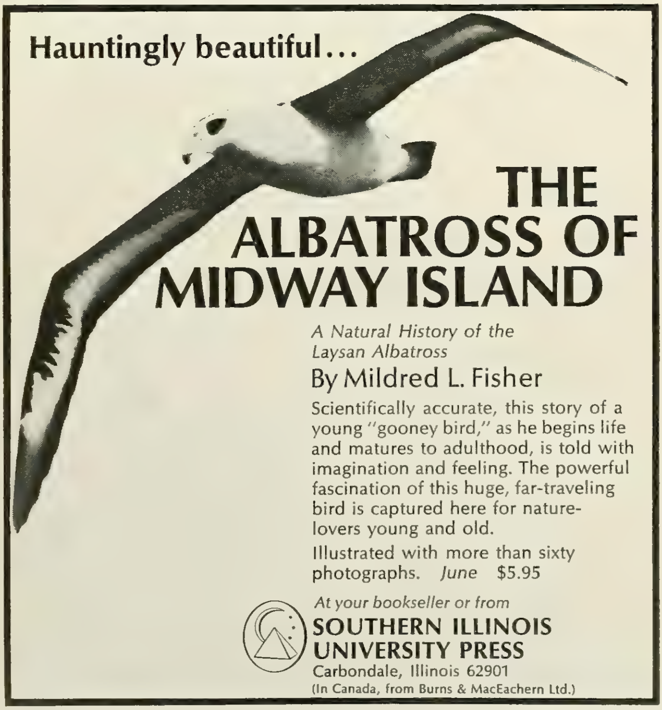

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published by Robert E. Ritzenthaler in *Sioux Indian Drawings*, and the paintings of two other Plains Indians incarcerated in Florida during the 1870's appear in *A Cheyenne Sketchbook* and *Howling Wolf*. *Isleta Paintings*, edited by Esther S. Goldfrank, is a valuable visual record of Pueblo ceremonial life. Many more Indian artists remain anonymous or have their works published in compilations by others, including such general works as Frederick J. Dockstader's *Indian Art in America* and Charles Miles's *Indian and Eskimo Artifacts of North America*, or regional collections such as Dorothy Dunn's *American Indian Paintings of the Southwest and Plains Areas* and Audrey Hawthorn's *Art of the Kwakiutl Indians and Other Northwest Coast Tribes*.

From among the customary ethnographic accounts, New Yorkers in particular will profit from reading about Iroquois culture in Hazel W. Hertzberg's *The Great Tree and the Longhouse*. In addition to traditional ethnographic accounts, descriptions of particular tribes by native sons are increasingly important sources of information. Outstanding examples are *Cheyenne Memories*, by John Stands in Timber and Margot Liberty, and *A Pictographic History of the Oglala Sioux*, by Amos Bad Heart Bull and Helen H. Blish.

My earlier reference to hippie spiritual practices records but one manifestation of the growing curiosity and, hopefully, respect for native American philosophy and religion, with its oral and ritual expressions. Four paperback anthologies of Indian stories and songs make enlightening reading: *American Indian Prose and Poetry*, edited by Margot Astrov; *Indian Tales of North America*, edited by Tristram P. Coffin; and the reprinted editions of *The Indians' Book*, songs and legends recorded by Natalie Curtis; and *Tales of the North American Indians*, assembled by Stith Thompson. A good comparative summary of religious beliefs in various tribes is found in Ruth M. Underhill's *Red Man's Religion*. Jack F. and Anna G. Kilpatrick have captured the spirit of religious thought in their book that deals with the Oklahoma Cherokees, *Run Toward the Nightland*. Finally, a southwestern pueblo will never be the same to the tourist who reads the overnight classic by Alfonso Ortiz, *The Tewa World*. All these works reveal how much of basic philosophical importance has survived in many tribes despite intimidation and persecution in the past.

Women are playing an important part in the ongoing struggle for Indian rights, as well as in the economic life of many tribes. This is reflected in the latest autobiographies of Indians, most of which are by women. The life of *Mountain Wolf Woman, Sister of Crashing Thunder,* edited by Nancy O. Lurie, contrasts with the catastrophic events endured by her brother whose autobiography was published years ago by Paul Radin. Florence C. Shipik has brought us the tragic story of a California Indian in *The Autobiography of Delfina Cuero, A Digueno Indian.* Some Indians forsake their tribal lives but maintain an Indian identity in another culture. The lives of two such Indians, the first, a Navaho and the second, a Hopi, who left their natal villages are recorded in Kay Bennett's *Kaibah* and Polingaysi Qoyawayma's *No Turning Back.* Not to deny the men, however, readers will enjoy the autobiography of a Mackenzie Delta Eskimo, *I, Nuligak,* edited by Maurice Metayer.

The news stories about Indians are making the invisible American visible, but the activities that generate these features and the outpouring of books are a continuation of a series of events that, in a sense, started about the time of the National Indian Chicago Conference in 1960. Since then, Indians themselves have undergone a new sense of identity on reservations, in cities, and on campuses. The next decade will see more activities directed toward redressing past abuses and eliminating future maltreatment. For the reader, bewilderment will turn to comprehension through an understanding of the conditions of American Indians today. The historical background is clearly illuminated by William T. Hagan's *American Indians.* Excerpts from documents detailing Indian–white relations are found in *The Indian in America's Past,* by Jack D. Forbes, and for those desiring fuller documentation, Wilcomb E. Washburn's *The Indian and the White Man* is superb. Accounts of the processes and results of culture change in various Indian communities can be obtained in a scholarly volume edited by Edward H. Spicer, *Perspectives in American Indian Culture Change.* A more readable and less copious discussion is found in *Apologies to the Iroquois,* by Edmund Wilson. The fate and dilemma of communities that claim undocumented Indian ancestry are revealed in Brewton Berry's *Almost White.*

The problems currently confronting Indians and the reasons their solutions are so perplexing are explicated in a series of very important books. In a short book, *The Indian Tribes of the United States,* D'Arcy McNickle

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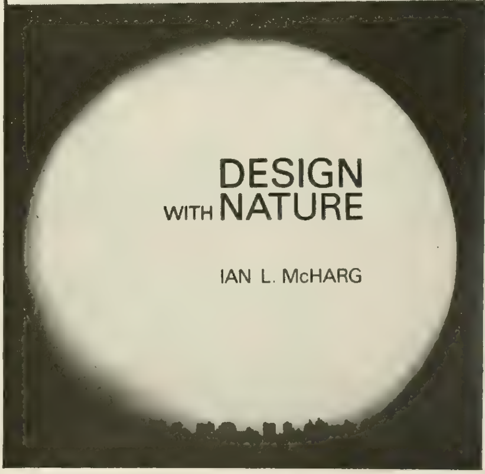

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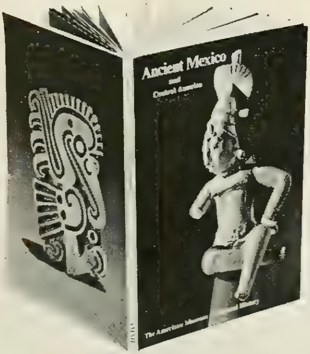

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examines governmental policy and the persistence of the Indians. William A. Brophy and Sophie D. Aberle spell out legitimate grievances and future needs in a scholarly and statistical fashion in *The Indian: America's Unfinished Business.* Contemporary conditions of Indians in general as well as problems of specific tribes are presented in Stuart Levine and Nancy O. Lurie's *The American Indian Today.* Difficulties Indians encounter in dealing with the government are outlined in *Our Brother's Keeper*, edited by Edgar S. Cahn for the Citizens' Advocate Center. Despite seemingly insurmountable obstacles. individual Indians have made progress and others are actively challenging the status quo. The recent struggles by Indians to secure their rights is chronicled in sensational journalistic style by Stan Steiner in *The New Indians.* Finally, an important presentation of Indian wants—to remain Indians. to retain their lands, to make their own decisions, and to receive developmental assistance, among others—is spelled out by Vine Deloria, Jr., a leader in the Indian rights movement, in *Custer Died for Your Sins.*

These selections of literature about the unvanishing Indians are my personal recommendations. They should enlighten the reader's perspective of pre-Columbian and aboriginal life ways, in addition to elucidating contemporary Indian conditions, needs, and reactions.

Dr. Ford is an assistant professor of anthropology at the University of Michigan, specializing in ethnobotany and cultural ecology of American Indian societies, past and present.

BACK TO NATURE: THE ARCADIAN MYTH IN URBAN AMERICA, by Peter J. Schmitt. *Oxford University Press, $6.50; 230 pp.*

For a long time I've watched for a scholarly attempt to analyze a vigorous American phenomenon: the activities of our early twentieth-century naturalists. The subject has needed detailed treatment for years, and I always expected the definitive study would finally be accomplished by a naturalist. But Peter Schmitt is a historian, and it's probably better that way after all. I guess this book is the one I've been looking for.

Remember the nature writers? The old-timers, I mean: gray patriarchs like John Burroughs and "John O' Mountains" Muir, wise woodsmen like Dan Beard and Ernest Thompson Seton, romantic novelists like James

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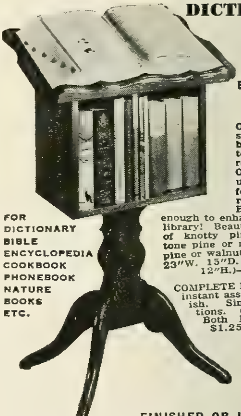

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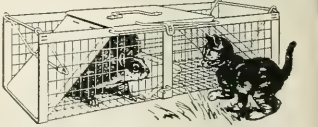

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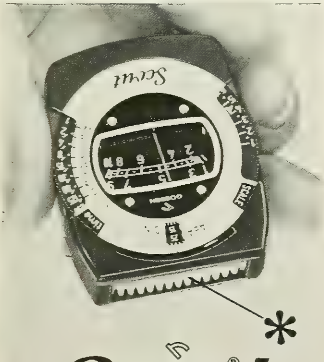

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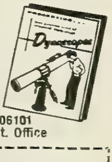

Oliver Curwood and Stewart Edward White. All of them worshiped the outdoors, and all took overlapping generations of readers with them on their rambling jaunts. With Burroughs, one's adventure was intensive, cultivated, and literary; his eye was for *vulgaris*, common things. Seton, Curwood, and White, on the other hand, wrote of (and in) superlatives—blizzards, wolves, and fires in the "tall uncut." Some of the prolific fictionists and essayists were really terrible writers whose imaginations often manipulated any chance accuracy of observation. But others, like Jack London and Dillon Wallace, were able to weave good, loquacious tales that actually made their authors seem grizzled despite a minimum of trail experience.

On a personal level, *Back to Nature*, which is part of Oxford's "Urban Life in America" series, brought me back to some old, long-unread friends of my youth. I'm afraid I flinched at Schmitt's objective treatment of them, but I have to state that the formal reintroductions were, for me, a delight.

Schmitt's thesis is that the nature writers gave best expression to a pursuit that has always dwelt deep in American culture and still does. He calls it the Arcadian myth, the quest for some kind of natural utopia in the outdoors. Ironically, he points out that most of these wilderness lovers were city folk who fled to the suburbs and never stayed away too long when they did head into mountains or forests. Many of them were condescending toward native country people who lived far from urban centers the year-round. So the myth, according to Schmitt, was a city myth—the grass looked greener from there.

But writers weren't the only ones looking for Arcadia. The author considers landscape architecture, park planning, the camping mania, and the ups and downs of the scouting and conservation movements as important aspects of this romantic quest. Interest in nature came to a head roughly during the first quarter of this century, and, Schmitt maintains, it still figures prominently in American consciousness.

Today we see this Arcadian impulse regenerating in the wide concern with the environment and ecology. Planners like Ian McHarg and naturalists like Joseph Wood Krutch and Edwin Way Teale are direct descendants, widely read and respected. The heavy traffic not quite absorbed by our state and national parks these days also indicates that the myth is alive and well.

Peter Schmitt has made some sense

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of this particular madness, no question. And I like his book. But O adolescence! I'll never forget the balsam scent in White's *The Forest*; the chilling terror of Dillon Wallace's *Lure of the Labrador Wild*; the ethereal beauty of Curwood's defiant virgins against a backdrop of clear lakes and raging rivers in the far North. Because, for better or worse, I grew up with them. Despite the well-deserved obscurity of most of them today, it's nice to know that historical scholarship has finally recognized and treated them right.

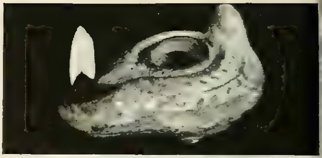
JOHN EASTMAN

CONSERVATION: NOW OR NEVER, by Nicholas Roosevelt. *Dodd, Mead & Company, $5.95; 238 pp.*

There are not many still around who talked with Theodore Roosevelt, argued with Gifford Pinchot, and went on from there to get in on the great conservation struggles of the 1960's, including the fight to save the Big Sur coast and the battle of Storm King. But Nicholas Roosevelt, cousin of T.R., was there through it all. Consequently, when he takes time to write a book, it behooves the latecomers to the environmental crusade to take a little time to read it.

Conservation is an excellent review of conservation history, from Hetch Hetchy to the Redwood National Park, written by a participant. Some of the stories have been told before, but not from the vantage point of one who knew all the actors. One realizes from this book, all too keenly, just how much difference it can make to have the right man in the right place at the right time. Unfortunately, but nevertheless inevitably, the history of conservation success, even the recent gains under the massed banners of new recruits, is a history of individuals. Earlier it was a Roosevelt, a Muir, or a Mather. Today perhaps it will be a Stewart Udall, a Russell Train, or a Nat Reed. Behind them are other individuals, usually alone or in small groups, digging out the facts, writing the proposals, testifying before hostile committees. Mass support may tip the political balance, but it is never aroused without the efforts of the few who must at first carry on in a seemingly hopeless struggle.

Conservation books, even my own, make me angry. It is wrong that the kind of exhausting struggle to some dubious conclusion described again and again in this book should have to occur. Why should we have to argue, as Roosevelt does, in the affluent America of the 1970's, that the view from the road should not be ugly? Why should we still be fighting the



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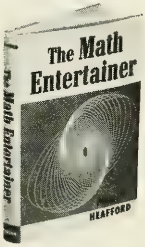

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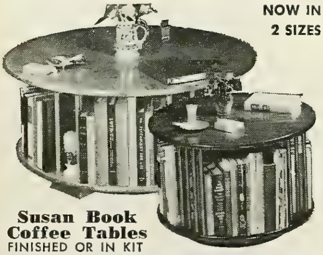

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entrenched arrogance and embattled viciousness of bureaucrats in such organizations as the Bureau of Public Roads, state highway departments, Army Corps of Engineers, and similar narrow-minded agencies? It is time that their power was transferred to other, more responsible hands. It is also time. as this book will bear out, that the right of a landowner to do what he pleases with his lands—the greatest single cause of environmental degradation in America today—was brought into serious question.

Nicholas Roosevelt is more charitable and tolerant than most conservationists are inclined to be today. I think that tomorrow those agencies that were in his opposition will wish that he were back.

RAYMOND F. DASMANN
The Conservation Foundation

Briefly Noted:

S/S/T AND SONIC BOOM HANDBOOK, by William A. Shurcliff. *Ballantine Books, $.95; 153 pp., illus.*

Dr. Shurcliff has written an angry, persuasive book opposing the building of the supersonic transport plane. He has numerous objections to the plane—passenger discomfort and danger, possible damage to property—but it is the sonic boom that draws his main fire. The possibility that "500.000.000 persons in America. Europe, and Asia may be jolted every hour. day and night. by sonic booms" is truly staggering. The book is not an emotional diatribe. but a carefully documented presentation of just what the plane will cost the public in dollars, degradation of environment, and bombardment by noise. A number of helpful appendixes are included—the first, and foremost, a list of anti-boom groups to join. C. B.

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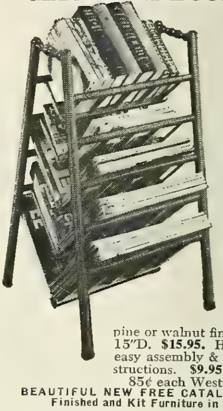

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MURDER FOR PROFIT

photo by Brian Davies

The baby seal in the photo was one of 50,000 killed in the Gulf of St. Lawrence, one of over half a million seals clubbed, speared, shot, gaffed during the 1970 Canadian-Norwegian slaughter in the Atlantic.

Don't believe furriers who would persuade you that Friends of Animals has been "misleading" you, that any slaughter anywhere is done for the benefit of the seals.

I, Alice Herrington, testify that on March 21, 1970—the second day of the Canadian season on seals—I saw the same brutal massacre against which Friends of Animals, of which I am president, has been protesting for years. As the bubble-domed helicopter flew low over the first day's kill, I saw mother seals nuzzling the skinless corpses of their babies. Standing ten feet away from the killers on the ice floes, twenty miles out in the Gulf, I saw baby seals, clubbed twice, and then sliced open. Other babies were battered as many as fourteen times while the mothers watched in terror and stress.

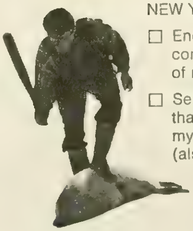
If You Are One Who Cannot Be Indifferent to the Suffering of Other Creatures

YOU CAN HELP

First—by refusing to garb yourself in the agony of another, by refusing to buy the skins of wildlife.

Second—by causing this advertisement to be inserted in your local newspaper. (A mat will be sent upon your request to Friends of Animals. See coupon below.)

Third—by sending a tax-deductible contribution to Friends of Animals, Inc., a non-profit organization that intends to pound on the world's conscience until sentient men and women everywhere are made aware of the unnecessary cruelty and destruction being inflicted upon animals. Your contribution will be used to plead for those creatures who cannot speak for themselves but who dumbly implore your pity.



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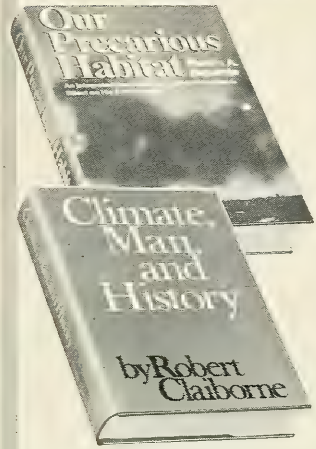

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Suggested Additional Reading

LET'S SING "AULD LANG SYNE" FOR THE UPPER BRANDYWINE

Forest Landscape. R. B. Litton. USDA Forest Service. Paper PSW-49, Berkeley, 1968.

Design with Nature. I. L. McHarg. The Natural History Press. Garden City, 1969.

Brandywine Basin. P. Thompson. *Science*, March 14, 1969.

THE STAR DRAGON

Apollo 11 Observations of a Remarkable Glazing Phenomenon on the Lunar Surface. T. Gold. *Science*, September 26, 1969.

The Field Notes of Captain William Clark 1803-1805. E. S. Osgood, ed. Yale University Press, New Haven, 1964.

THIS GENTLE & ELEGANT CAT

The Cats of Africa. M. Edey, ed. Time-Life Books. New York. 1969.

Simba. C. A. Guggisberg. Chilton Book Company, Philadelphia, 1963.

The Tiger and Its Prey. G. B. Schaller. *Natural History*, October, 1966.

BARRIER BEACHES OF EASTERN AMERICA

Waves and Beaches. W. Bascom. Doubleday & Company, Inc., Garden City. 1964.

The Winter Beach. C. Ogburn, Jr. William Morrow & Co., Inc., New York. 1966.

Development and Migration of Barrier Islands, Northern Gulf of Mexico. E. G. Otvos. Jr. *Geological Society of America Bulletin*, Vol. 81. No. 1. 1970.

TINY WOLVES OF THE WATER

Fresh-Water Invertebrates of the United States. R. W. Pennak. The Ronald Press Company, New York. 1953.

Freshwater Biology. W. T. Edmondson. ed. John Wiley & Sons, Inc., New York. 1959.

The New Field Book of Freshwater Life. E. B. Klots. G. P. Putnam's Sons, New York, 1966.

MUSHROOMS

The Mushroom Hunter's Field Guide. A. H. Smith. University of Michigan Press, Ann Arbor, 1963.

The Field Book of Common Mushrooms. W. S. Thomas. G. P. Putnam's Sons. New York, 1948.

The Savory Wild Mushroom. M. McKenny. University of Washington Press, Seattle, 1969.

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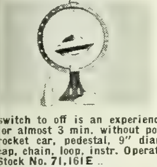

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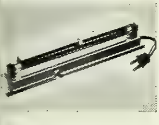

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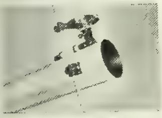

Take exciting moon pictures. Bracket attaches to any telescope. Removable rod with adjusting bracket holds camera over scope's eyepiece. White metal sun projection screen included. Just attach to holder, point scope at sun, move screen to focus . . . see sunspots! Includes brackets, 28¾" rod, projection screen, screws, directions. Aluminum; black crinkle brackets.

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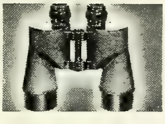

Big savings! Brand new! Crystal-clear viewing—7 power. Every optical element is coated. An excellent night glass—the size recommended for satellite viewing. Individual eye focus. Exit pupil 7 mm. Approx. field at 1,000 yds. is 376 ft. Carrying Case included. American 7x50's normally cost $274.50. Terrific bargain.

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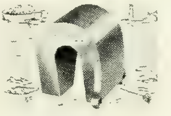

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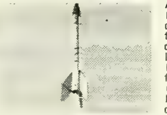

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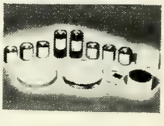

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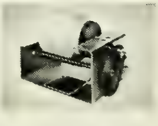

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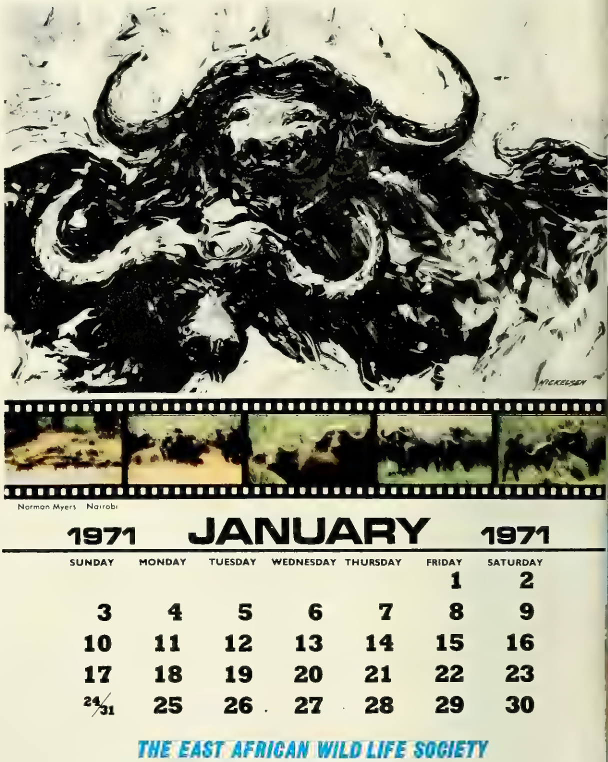
1971 Calendar

The artist and designer of the Society's 1971 Calendar is Kenya resident Harald Olaf Nickelsen. Each page of the Calendar features a black and white study of East African game or scenery. Below each painting are five still photos in full color drawn from some of the region's top photographers.



1971 JANUARY 1971

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
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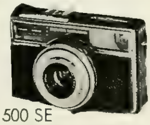

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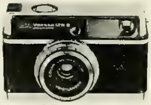

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INCORPORATING NATURE MAGAZINE

The Journal of The American Museum of Natural History

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Publication Office: The American Museum of Natural History, Central Park West at 79th Street, New York, N.Y. 10024. Published monthly, October through May; bimonthly June to September, Subscription: $7.00 a year. In Canada and all other countries: $7.50 a year. Single copies $1.00. Second-class postage paid at New York, N.Y., and at additional offices. *Copyright © 1970 by The American Museum of Natural History. No part of this periodical may be reproduced without the written consent of* NATURAL HISTORY. *Manuscripts and illustrations submitted to the editorial office will be handled with care, but we cannot assume responsibility for their safety. Opinions expressed by authors are their own and do not necessarily reflect the policy of The American Museum.* NATURAL HISTORY *incorporating* Nature Magazine *is indexed in* Reader's Guide to Periodical Literature.

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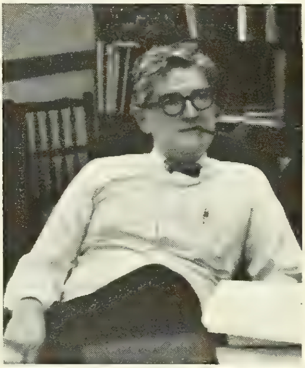
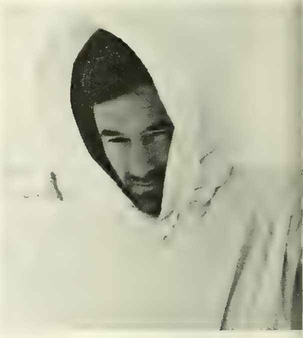
Authors

E. F. Roberts is a professor at Cornell University Law School and a member of the Massachusetts Bar Association and the American Law Institute. His article treats his longstanding concern—land-use planning and environmental law. A graduate of Northeastern University with an LL.B. from Boston College, Roberts is preparing a book on this subject within the framework of environmental planning.



Richard Brewer, author of "Death by the Plow," is associate professor of biology at Western Michigan University. He is primarily interested in the organization and evolution of ecosystems; in particular, the relationship between ecosystem organization and the population structure and life history of the constituent organisms. He plans future studies on the community organization of oak forests and on habitat selection in birds.

A film maker and photographer, **Steven C. Wilson**'s field studies include the migration of the barren-ground caribou in the Arctic and a photographic survey of the Great Plains region of North America. Mr. Wilson has recently completed a documentary on the ecology of American rivers entitled "Dam the Downstream," part of a series of hour-long color films on man and his environments.



John Bardach is professor of natural resources at the University of Michigan where he directs a lab-

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oratory specializing in physiological ecology of fishes. He is also the author of two popular books on man's interference in the hydrosphere, *Downstream* and *Harvest of the Sea.*

Coauthor of "Three Fleeing Bullheads" and Bardach's assistant, **Trudy Villars** is the fish observer and trainer. Her involvement in studies of the behavioral mechanisms of learning, particularly in rats, stems from her interest in physiological psychology from the behavioral point of view.

An intuitive impulse coupled with her Welsh-Irish background led **Lisa Stephens** to spend two years in Ireland during 1963-64. Through reading the Irish playwright, John Synge, she became particularly interested in the Gaeltacht area of West Kerry, and her current photographs celebrate this region. A photographer for twelve years, Stephens originally majored in history at UCLA and studied drawing and painting with several leading California artists. As a continuation of her interest in Gaelic culture, she is currently spending six months in the Hebrides working with film and still photography and studying the similarities and differences between the Gaels of Scotland and Ireland.

Henry Lansford's article on inadvertent weather modification grew out of his work at the National Center for Atmospheric Research in Boulder, Colorado, where he has been a public information officer since 1965. Previously, Lansford worked for the United States Atomic Energy Commission as publications officer. He has written articles on the atmospheric sciences natural history, and other subjects for a variety of publications.

John P. Kelsall has written extensively on the barren-ground caribou, the subject of his current article. After traveling and working in the Canadian Arctic for nin years with the Canadian Wildlif Service, Kelsall attended the University of Western Australia wher he received his Ph.D. in zoology i 1965. At present, he is a researc scientist for the Canadian Wildlif Service, fellow of the Arctic Institute of North America, and director of the Canadian Society o Wildlife and Fishery Biologists. H is currently at work on a study o waterfowl plumage and its possibl applications in aging and sexin birds.

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Cole Weston: *Surf and headlands, Big Sur, California*

January 7-10

Big Sur Storm

by Sam Abrams

Yesterday Big Sur looked like ermont by the Pacific, sycamores roviding the fall yellow. Today the seventh) I walked up the mesa nd down through the canyon to e sea. I saw the bushtit, local hickadee equivalent, supposed to e a small chickadee-like bird, but is not only smaller than the other embers of its family but finer, rawn out into warbler-like deliacy. Like chickadees and some arblers it is a tree cleaner, searchg over the leaves and crevices in e bark for dormant or slow insect orms . . . heard the western song parrow sing, January song sparows, vain to compare with the irds along the Charles in protected laces singing in February Masachusetts sun in alder swamp now ighway.

Still not at home in the West, the orms are surprising and extravgant—shrubs are trees, annuals welve feet high. Cannot find a lace to sit outside, although when he snow in Vermont was still two eet deep in the low woods, I found sun-warmed bank of graveyard all, shielding wind and reflecting ore sun, dry enough to lie down the cemetery six feet above the fields where plow and grazing had got at topsoil—another story). Not sure that my inability to find a place to sit down is purely ignorance, tradition of western leather pants and thorny drought armor.

Step out of the woods onto the beach, adjust to open society, the herring gulls around a fisherman all but talk English. Don't look them in the eye and they trust you. For a second. Competitive and vocal and smart.

The weekenders are like trading stamp catalog pics or, with a little more bread, like an Abercrombie window . . . they show up on the beach when a low tide coincides with a sunset on a weekend, with full wet suits, special clamming hoes, measuring bars attached, and clamming bags, and ten of them get one clam between them in three hours.

The catchers are mostly old retired, show up on a rainy weekday morning for the lowest tide of the month with equipment as elaborate and expensive as the weekenders but homemade. The superfisherman had made his own rod spike from about four feet of three-inch steel, two small, tin can bait cups soldered or welded to it, rag hook, big heavy-duty modern worn fiber glass pole, plenty of blood on it, expensive largest-size spinning reel. He rigged two hooks on either side of a three ounce or so triangular sinker, for one hook he had a bait can full of freshly dug sand crabs, mostly half inchers which he complained were too small, and for the other, store-bought fresh mackerel cut into blunt one and a half by three-quarter-inch wedges (with a very sharp knife) and soaked overnight in red food dye . . . reels in, rod in spike, inspects the bait two inches from the eye and drops a piece of mackerel and a live sandcrab (the gulls rustle a little in the waiting circle), picks up the rod, walks knee-deep, casts out right into the hole between the bars back up the beach, sets the rod in the spike, dries hands, watches rod tip there's a bite . . . he lost interest in talking to me when I didn't see the bite fast enough. I projected disgust at my inattention to the quivering rod top. I am always forgetting that the only way to tell the difference between the jerking of the rod/line caused by the sinker bouncing in the complex rhythm of the waves is

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the change in rhythm . . . he was a mean codger anyway. A pleasure to watch him unhook a fish, the economy of attention. I told him at the beginning I was not a good fisherman. The next time when he was talking with his buddy just back from clamming, homemade wet suit of plastic, parka with rubber bands at wrist, sneakers, caught nine in 45 minutes.

The Japanese are like the catchers but oriental. Stand behind one on the beach and the curve from his rod and all the curves of the bay transpose into Rangoon, Joseph Conrad, and the Dragon Lady. This guy is wearing Hong Kong waders and a plastic raincoat, baseball cap, has a big good modern rod but obsolete bait-casting type reel. The rod is fiber glass and must have been made for a spinning reel so he had to adapt, you can get very good bait reels cheap, but they have nothing like the range of the spinners, though an expert can be just as accurate within the limited range with a bait reel as with a spinner. His creel is homemade and very elaborate, army bag base with extra wide nylon straps and a smile-shaped foam shoulder pad on the strap covered in something black. He is catching small ones.

On a rainy day (the eighth), the skyscape and the mountainscape are even better. Pink washes over the Santa Cruz Peninsula, ten miles to my north, and to the south Monterey, massive Big Sur beyond it, thirty miles across the bay filling a full third of the horizontal orb of vision. Around the hundred and eighty horizontal degrees only two or three made up of the Moss Landing power station huge smokestack verticals, which disrupt the sweep of the eye from cloud mass to wooded peninsula to line after line of breakers and the wheeling lines of gulls——the actual dance of the planets. The huge tides we have been having and the beginning storm have not stopped the good fisherman who has been waiting for the tides, have driven the herring gulls from the docks to the low tide bars to scavenge on the discarded bait of fishermen and the undersized pismo clams . . . the limit on pismo clams is ten a day and the minimum size is five inches and all the clam hunters carry little U-shaped cast aluminum measurin bars in the fancy rigs attached t the shovel which has crosspiece and levers on it. But though they a have fancy rigs only the guys wh know the bars and the waters eve get any. The clams used to be harvested by huge horse-drawn rake and were a cheap item of food . . cockles and mussels alive alive . . . now they are only found ou on the last bar, they used to hol the whole intertidal, like the abalone. Luckier than the abalone the live in the roughest waters to murky for scuba gear even if yo could swim, so the remnant is onl vulnerable at the year's lowest tides These experts are getting near thei limits (up to seven inches) but the dig up thirty to fifty undersize ones for every bag of legal ones The law says that undersized one are to be replaced immediately i the holes from which they cam which is of course impossible in th roaring waist-high surf and shiftin sands, so they wash ashore for th gulls who are too numerous toda for the available clams and ar fiercely and vainly fighting ove them. I watch a mature adult gull bright black and white, scarlet spo glowing on yellow bill, all the sexual plumage of all the birds ha been growing brighter the las weeks . . . adult has a clam and i holding off three, no five, dusky immatures. He is clearly dominan enough over them all to keep then away from the clam but he can' drive them far enough away fo him to pick up the thing half-burie in sand and get up speed with th load and find an updraft and gai altitude and find a hard surface an drop it and recover. After five minutes of threats he lifts it up an takes off lumbering in toward th beach. He gets no more than twenty feet from the bar when he is vulnerable and one of the immatures attacks from behind and two o'clock high, forcing him to drop it at the edge of the surf on the main beach where it gets half-buried in the sand as he lands beside and easily beats off the others again and tries to dig it out. Less than five yards from me the five immatures and the adult arrange themselves in a precise geometry of fear and hunger. The anxiety lines from me and the dominant adult and the attraction

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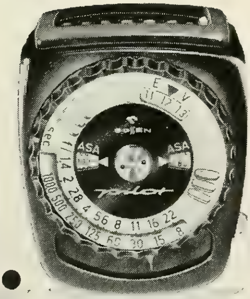

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lines from the half-buried clam clear as a radio diagram on the flat beach.

The superfisherman arm in arm with his wife arrives about twenty yards up the beach. I see from the gulls rearranging themselves and I take a wider sweep and see how the gulls are also taking into account the superfisherman and wife and basset hound twenty yards off and the clammer on the bar thirty yards off and the gulls wheeling high above and maneuvering for position to make a grab in space and wind. The gulls shift constantly insane paranoid complex taking in the whole gull scene edging for advantage. The basset walks straight to the half-buried clam and the gulls retreat very reluctant a few feet off eyeing him without much fear. He sniffs it and walks back to his master. I take my turn and with a firm but smooth pace I walk to the clam and lift it . . . over a pound, anyway . . . pismos have tremendously thick dense strong shells. I have a piece in front of me as I type, it has the heft and feel of old-time restaurant china like the plates we got for ten cents each at one of the many secondhand stores selling the stuff of the dead in Santa Cruz, city with more retired folk than any except Fort Lauderdale and somewhere else in Florida. The gulls weigh tops five pounds, average less, the adult picked up the clam the short way, and flew . . . tough-arse birds like crows, sea crows a Greek bird name, man followers, exploding first over the west coast of the Atlantic then the almost identical form on the American east coast, they are a weed bird, one that follows man's simplification of the environment, omnivores, garbage dump circles of gulls going a quarter of a mile into the golden afternoon air, late pm thermals spinning thousands of gulls above dumps here as in Cambridge freshpond shopping center or Tinbergen's Amsterdam . . . to gull, a city word, a civilized bird.

I rap about the gulls with the superfisherman from whom one can learn and find out that he had dug up and replaced seventy undersized clams recently and there are plenty of em left out thar and did not tell him that's what they said about the buffalo and started home and found
floundering on the beach a sic
probably oiled (Santa Barbara? it
over 300 miles of coastline aw
though the storm is from the south
adult male surf scoter. I pick hi
up in my silk scarf and cradle hi
to my chest and calm him by ma
saging the base of his neck with t
ball of my thumb the way I saw t
guy from Moss Landing e
perimental station do it like ha
dling a baby, delicate bones glidi
into relaxation in my arms. Scote
live above the pismo clams spen
ing all their time in winter in t
white water, bobbing and glidi
under the heads of the breake
. . . when the afternoon sun shin
through the green curls before t
moment of breaking you can som
times see the scoters swimming fl
ing underwater through the peak
the breaker . . . they fly pret
good, except for taking-off dif
culties, at best can only waddle
land which they visit to rest brief
at low tide when no one is on t
beach, half-buried in the wet san
in the last creamy inches of su
sometimes straining the syru
sand for food . . . living that wa
their feathers are fantastic i
sulation. They are fairly closely r
lated to the eiders I guess, t
feathers of the bird in my arms a
more like fur behind his neck, thi
and light, sable shiny black all ov
except for his proud sex marks
brilliant white cap on the back
his head running down his ne
just to where my soothing thum
rubs, a white spot on the face an
shiny ivory white bill with brillia
line of black and spot orange on
ther side. He sleeps in my arms a
I walk carefully, the long w
around so as not to disturb him
climbing, up the beach throug
the railroad cut, the scale beco
ing like childhood, like the Gre
scale, how far can you walk car
ing a duck . . . you cannot re
Aeschylus unless you have liv
without a car . . . through the p
vate road to the top of the cliffs a
home, wrap him in a dry towel a
the good old wool blanket and p
him on the seat of the truck whe
the kids won't disturb him. Josh
upset, wanting the bird to like hi
and be well and nobody in at t
experimental station where th
told me to bring oiled birds and t
newspaper and radio full of t

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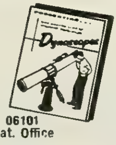

story of the "more than 3,600" birds who died despite treatment after the first Santa Barbara spill and we finally reach the ornithologist lady who says as I usually do say and believe that the best you can do is leave them on the beach to get better themselves and I guess she is right cause when I go to take him in the house before we go to the movies he is dead and stiff and I put him in a plastic bag and put him in the freezer compartment of the refrigerator next to the golden-crowned sparrow that flew into our picture window yesterday and console Joshua the best I can by telling him that although we can't bring the bird back to life we can take his body to the doctors at Moss Landing experimental station where they will use it to find out what's making the birds sick and so be able to help the other birds, more of a lie than even I know cause the receptionist at the experimental station tells us over the phone next day that they already have a freezer full of dead scoters and we went on to the movies, a long newsreel about North Vietnam, the same picture for thirty years, scared women clutching their children and hurrying for bomb shelters and ruins and *Modern Times* with Charlie Chaplin who I want to be when I grow up.

The storm (the ninth) was full lottsa rain, eucalyptus trees groaning and shedding long strips of bark. I notice culverts under what I thought was solid land and begin to dig how much work it is to hold this beach front, in a land of drought, erosion is always a mighty force . . . no one about except a state cop sitting in his car at state beach parking lot . . . drives up to me in my international yachting parka visible enough . . . concerned about a parked car with lights on, but I haven't seen anyone on the beach since early morning fisherman and do not as I walk down the beach . . . every rainy day. With this much vista part of the sky is clear and today it is an arc, a lozenge, no more than thirty degrees along the horizon and reaching no more than ten vertical degrees, say 95 percent of the sky is overcast except for this inverted smile reaching twenty degrees north to ten south of due west and the sun sets in it, appearing from behind
the one hundred seventy degrees
gray, the entire red disk of the su
filling the center of the clear a
. . . there are two rainy-face
teenyboppers who don't own the c
with the lights on and a big pie
of ship planking twenty by twen
with a hatch is stranded by t
beach shack.

Clear (the tenth) after two da
of heavy rain, down on the beac
just after turn of very high tid
hardly room to walk, waves st
have storm force and wash almo
up to the sharp fresh-cut ban
heaped with new wracks of jetsa
sea-sorted by size and specific gra
ity . . . sky over the semicircle
bay is clear except for fine herrin
bone lace of altocumulus throug
which the sun has no trouble shi
ing, over the peninsulas to nort
and south triangular flying wedg
of cumulus climb echoing t
shapes of headlands. Two local ki
pass on a minibike disturbing t
birds and crushing the succulents
they are forced to ride above t
cut banks, waves not leaving the
enough room on the sand and
don't stop them and ask if the
aren't afraid with their stink of t
beach gods and sea gods. Remem
ber the chief narc who got gobble
by a freak wave at Acapulco la
summer. They get ahead and
watch a flock of eleven wille
where three months ago there was
flock of three hundred sanderling
thirty or fifty willets seventy
eighty marbled godwits and tw
black-bellied plovers. The eleve
are tired and manage to arrang
themselves with a lot of anxiety an
pushing around by one domina
bird, tuck their bills under wing
eyes open, prop up on one locke
leg . . . I carefully walk aroun
them in the brush, not lookin
toward them and manage to get b
without disturbing them . . .
people knew what a tough life the
led, would they bring their dog
western dogs are all saner and ha
pier and well mannered, to cha
them on the beach . . . I feel relu
tant to walk on the beach unt
there is room to do it without bu
ging them . . . the weirdest pie
of shiny black jetsam, some flow
from the depths of the kelp fores
stem resolves itself into a neck, s
pals into wings, closed petals in
the body of a seabird, duck

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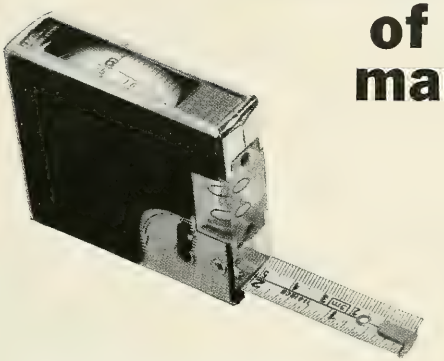

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troville, "artichoke capital of th
world," spaced fields of miles o
nothing but artichokes, then mile
of apples, factory with flower
river picks up the pesticides an
runs out past Moss Landing, an
sometimes crop-dusting copters wi
buzz and dust off a flock of seabird
for fun and they often dump thei
extra into the ocean and the ba
thirty miles across, has eddy cu
rents . . . they recently did firs
tests for sewer pollution in Mont
rey Bay, lowest reading in the ope
sea off Pacific Point was eleve
thousand per milliliter or liter
whatever of coli bacteria when th
limit is one thousand. We are use
to the sight of dead and dying an
rotting birds and sea lions . . . b
these oiled birds must have com
all the way from Santa Barba
channel more than 300 miles
coastline away where they had a
other leak a week or two ago.

The beach shack has collapsed i
the storm and is beyond repair
one man and two boys . . . th
piece of shipdeck is awash again,
at least half of it, the waves to
and twelve-foot lengths of two
fours detach themselves and a
caught on the beach . . . there is
grebe flopping about in the san
. . . we gather round him . .
western grebe, long white nec
gray back, sharp yellow bill a
mad red eye, his feet semiwebbe
fronded, and green, he flops aw
from us and we leave him and
saw a grebe the next day swimmi
all right closer in than they usual
stay and hope it was him reco
ering and when we get home fro
the beach there is a letter telling
that Charles Olsen, the teacher
our friends, is dying . . . a m
who through the yahoo years
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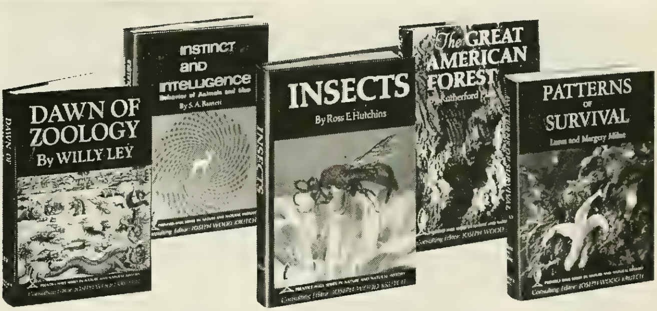

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An environmental lawyer urges:

Plead the Ninth Amendment!

by E. F. Roberts

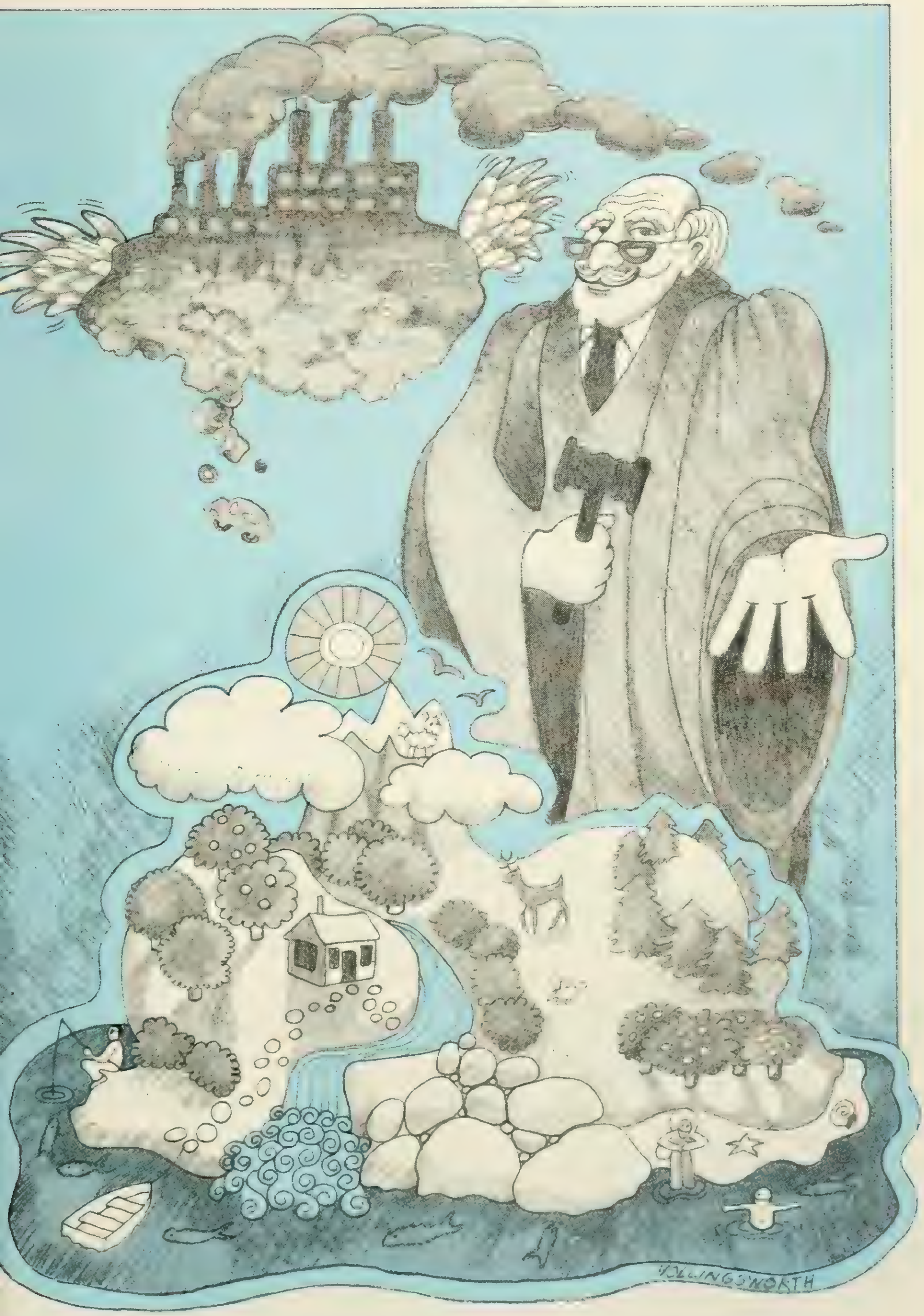
Picture a man sitting in his house on a hill overlooking a lake. Pausing in his ruminations to look out the window, he must gaze through a maze of electric utility pylons in order to enjoy his view of the lake. The lake water, once blue, has been changed to a murky gray by sewer effluents and by thermal pollution from a nearby atomic power plant. To drown out the noise of a jet aircraft he turns up the volume of his stereo while wiping away the dust that has wafted in from a recently opened cement factory. This reminds him that the cement is being poured for the foundation of a new hi-rise apartment house being built at the last remaining natural spot on the lake.

Perhaps this description will make the reader inquire about the legal system that permits such a scene to occur. The inquiry could be a ghastly experience because the law can be a dreadful bore. But let's have a try at it.

The law's concern with order and justice is immutable, but this is not so for the work-a-day rules that maintain order while justice appears to be done. Rules normally change so slowly that they appear to be immutable to any one generation. Indeed, when too many rules change too quickly, a sense that something is wrong with the system may afflict society—witness some of the reaction engendered by the Warren Court in recent years. Such reactions and criticisms often are meritorious because, in the last analysis, the law depends for its effectiveness upon its acceptance by the governed, and this acceptance depends in large measure upon the law appearing to be a fairly immutable set of principles, rather than a hodgepodge of *ad hoc* responses concocted by pragmatic lawyers.

Periodically, however, the whole system of rules is overhauled in relatively short order when, during an economic or social convulsion, the society's fundamental notions about justice undergo a dramatic change. Because a legal system does not command so much as it channels social activity into peaceful avenues, during these convulsive periods the judges rapidly restructure the rules. This restructuring keeps the system responsive to the felt needs of society. We are now living through one of these traumatic periods, and the recent concern wit the environment typifies the new social values that are causing th judges to overhaul the rule syster with haste.

Suppose, for example, that coke-manufacturing plant had bee built in an American city durin the late nineteenth century. Th manufacturing technique of th time involved quenching the burning coal with water, a process tha generated vast clouds of gases smoke, and soot and rendered th neighborhood uninhabitable fo gentlefolk. If the old-time resident turned to the law for help agains the plant, they found a doctrin dating back to the reign of Henr II to the effect that no one shoul do things on his land that woul disturb his neighbors' enjoyment o their land. Presumably, the homeowners in our hypothetical situation should have been able to obtain either an injunction to stop th polluting of their environment or judgment for money damages commensurate with the depreciation i value inflicted upon their homes. I all likelihood, however, they woul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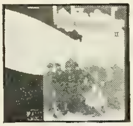

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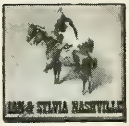
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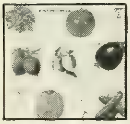

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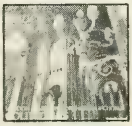

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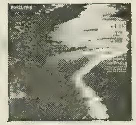

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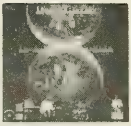

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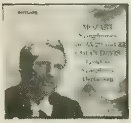

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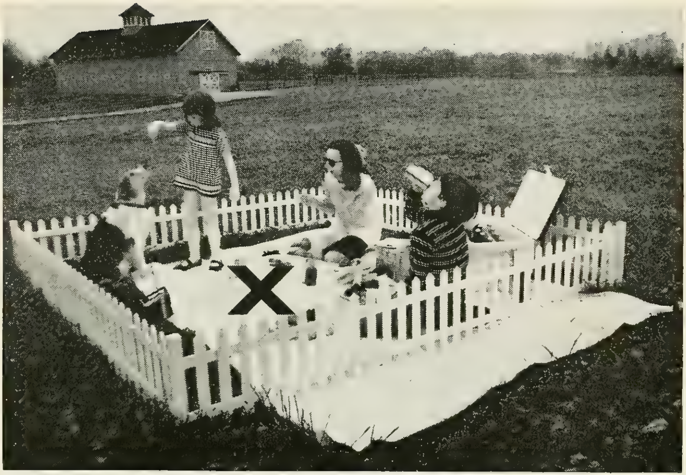

If you could shoot on both sides of this fence you could make better movies.

Sit down at X and we'll show you why.

All set? Okay. You've brought a camera along. Any conventional super-8 camera.

This is your picnic. You're going to bring it back alive.

Shooting it just as it happens. So, between bites, start picking shots. How about this one?

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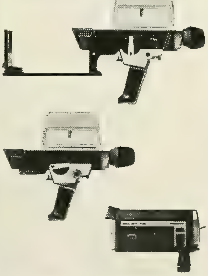

The Bolex 160—with power zoom and single-frame release—and the Bolex 155 focus from one inch of the lens to infinity. Handheld. Without attachments. The 7.5 does the same thing from 5 inches, like this.

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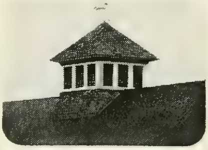

And if you snap on the free little Multitrix attachment, you can title on location, like this.

Shoot stills. Shoot—and dissolve through—a slide. Make complete movies in the camera.

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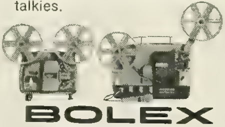

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have gotten nothing, no satisfaction at all, because the law went through a convulsive period early in the nineteenth century.

During the Industrial Revolution rules were overhauled wholesale, and the values of the agrarian society evolved into a new *coda* compatible with commerce and manufacturing. Under the prevailing ideas of laissez faire, or rugged individualism, conventional wisdom was reoriented around personal responsibility, and government was relegated to a minimal role in a society governed largely by the natural laws of the marketplace. Action, go-getting, and progress became virtues. Consequently, no one, including that mythical "legal person," the corporation, was to be held liable for the harm his actions occasioned others unless it was clearly the actor's "fault." Put another way, the losses occasioned by accidents in a rugged society had to be borne by the victims. This conventional wisdom, when crystallized into law, amounted in effect to a subsidy to incipient industry during the takeoff period of industrialization.

In this restructuring process the law of nuisance was translated into the prevailing ideology of fault. Our hypothetical coke manufacturer was not at fault—in legal terms he was not negligent—because he followed the accepted procedures in the manufacture of coke. Equally manifest, he was not at fault in locating his plant in the city because capital, labor, raw materials, and transportation routes converged there to make large-scale manufacture possible. Therefore, the harm visited upon the city's residents had to be chalked up as an accidental by-product of progress.

Ours may have been more of a class society than we generally realize, or agrarian values may have persisted outside the cities. I say this because, had our hypothetical entrepreneur attempted to build his coke plant in a polite suburb, he would have been enjoined at the drop of a hat. Notice carefully that he could not have been faulted if he had followed accepted manufacturing techniques; rather, his fault would lie in locating his plant in an area more suitable for residential development. To an extent, law con-

The flower with 400 personalities.

There's a Protea no more than one inch high, and there's a Protea tall as a tree.

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A little off the beaten track.

trolled the environment even durin the wilder phases of the Industri Revolution by segregating the env ronment into clean (country) an dirty (city) zones. In 1932 or judge, apparently giving solace t some neighbors of a particularly o fensive coke plant, preserved th dichotomy for posterity when h calmly observed that one "wh chooses to live in the large cente of population cannot expect th quiet [?] of the country."

The energies released by the I dustrial Revolution have been t undoing of the conventional wi dom of that phenomenon. The pro pering factories that have coa ulated in the cities, belching fum and disgorging chemically exot wastes, have created conditio whereby the chance occurrence of weather inversion can turn a ci into a death camp. The banker lawyers, advertisers, and executiv associated with commerce and i dustry realize too well that th must work in the cities. The cit dwelling working class, increasing cognizant of its power to disrupt, no longer put off with nineteent century sophistries to justify i deteriorating environment. With t exhaust from automobiles, even t most self-rusticated suburbanite h come to recognize that the old se regation approach no longer i sulates him from the dangers pollution. Worry over the deteri rating quality of the environment no longer endemic to a few ivor tower-based ecologists; insecuri has spread through the body po tic. It is only to be expected th judges should begin to tinker wi the rules of nuisance law in ord to make the law more responsive the felt needs of the day.

Should our hypothetical entrepr neur open his coke plant in an u banized area today and shower p lutants upon his neighbors, t result would be different but, inte estingly enough, not totally. Agai given the facts that the area was a propriate and that convention manufacturing techniques were e ployed, the plant probably wou be assessed with a judgment f money damages to offset declini values in the immediate neighb hood. In all likelihood, however, i injunction would be issued to clo the plant. This halfway change

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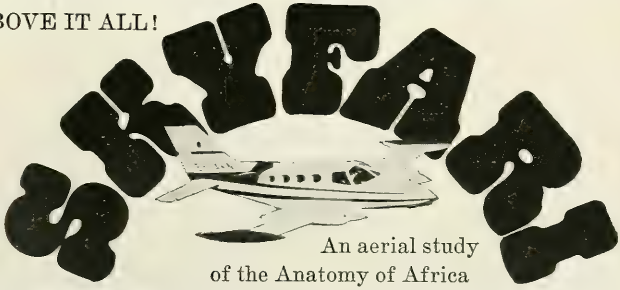

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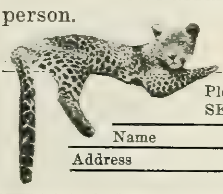

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nuisance law aptly reflects today's conventional wisdom.

During the nineteenth century if some defective item slipped through the manufacturing process without anyone's fault, the consumer suffered the loss if he was hurt as a result. Today the manufacturer has become liable, fault or no fault, for the damages suffered by the consumer. In today's scheme of values, a sense of security, a feeling of being able to rely on the products of modern industry, has replaced the old sense of individual fortune, for good or bad. Modern industry calculates an addition to the regular price of each item in order to create what amounts to an insurance fund to cover the costs of these accidents. Looked at another way, because he contributes to a fund set up for his unlucky colleagues who happen upon a defective product, the American consumer participates in a system of social insurance every time he buys a product. Thus, in handling pollution cases such as our hypothetical coke plant, judges who rule that manufacturers are responsible for damages inflicted upon their neighbors, are simply applying the already current idea that a product should bear its true costs, including the cost of damages.

Exercising their power to enjoin nuisances, the judges could shut down our hypothetical plant. This option, however, still gives the judges chance to pause. Increased production, more jobs, and more taxable enterprises are still basic ingredients in the accepted economic formula for relieving the plight of the poor. Shutting down plants would decrease employment opportunities and subtract from the number of taxable enterprises necessary to sustain current welfare programs. While judges have been willing to restructure the rules to accommodate the law to contemporary needs, they are unwilling to recast the law into a new mold until they are certain that society has rejected growth as the keystone of its value system.

The judges are saying, in effect, that the solutions to industrial pollution must be devised by the legislative branch of government. Whether the public is willing to pay the price for eliminating pollution is better ascertained through the

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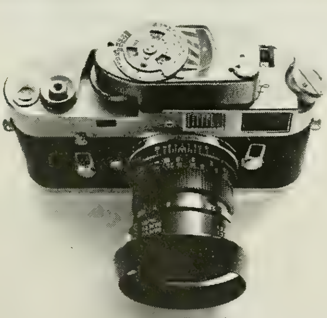

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ballot box than through the best hunches of the judiciary. Whether the costs of a program should be borne by the public via relatively higher taxes, which would be the case if industry were given generous deductions for environmental programs, or whether everyone should pay the extra costs imposed by an enforced system of environmental quality standards, is a question of high policy. Innumerable options for solutions come to mind. Lawsuits, which only decide who won and who lost—after the fashion of a feeble computer programmed in binary logic to respond with either "0" or "1"—are not apt forums in which to hammer out broadly gauged and complex programs of social reform. In short, lawsuits do not hold forth the promise of immediate solution to the environmental mess into which we have gotten ourselves.

While we wait upon the legislature to devise programs to clean up the mess we have created, judges have taken to working out new rules that would checkmate the spread of pollution. They have come to recognize that laissez faire has been replaced by a Keynesian mixed economy, which legitimizes a working partnership between business and the government to create a highly planned economy designed to achieve steady growth without untoward inflation. This partnership is often managed under the powers of a semiautonomous public agency. Considered from the perspective of over-all material plenty, this alliance cannot be faulted. In terms of the environment, however, this growth-oriented behemoth, which tends to make its decisions effective through various regulatory agencies, can become a menace. An agency decision to allow a pipeline across Alaska, an oil rig off Santa Barbara, a hydroelectric reservoir in a beautiful valley, or a supersonic transport route across the entire country can license the ravishment of what is left of our unspoiled environment. Is it possible to devise a containment policy to see that this does not happen?

The mixed economy illustrates anew how convolutions in the underlying society have made traditional rules of law obsolete. Bureau-

ary Carnwath isn't trying to save the world. st a little piece of it.

he Hopi Indians' village of Ship-
i in Arizona sits on land so poor,
ile and inhospitable that so far no-
has tried to take it away from

lectricity has not yet reached the
s. Water must be hauled from
miles away. Jobs are few and far
. Only poverty and despair are
by and in abundance.
et for the first time in generations,
Carnwath and people like her are
ıg hope among the Hopis.
lary Carnwath works and lives
housand miles away, in Manhat-
Her own daughter is now grown-
nd through Save the Children Fed-
ɔn she is sponsoring one of the
e girls, 8-year-old Grace Mahtewa.
he Mahtewas (two parents, three
en, one grandmother and a sister-
v) live tightly packed in a tiny
and mud house. The father, who
s ranch work but can't find any
of the year, isn't able to provide
mily with even the bare necessities.
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trious, would possibly have had to quit school as soon as she was old enough to do a day's work. But, because of Mary Carnwath, that won't be necessary.

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crats and businessmen in the agency system may make good economic judgments, but who speaks for the environment? Who can appeal to the courts when an agency decision threatens to license an unconscionable environmental atrocity? Traditional rules are not much help because hitherto plaintiffs have complained about damage inflicted upon their own persons or their own homes; what claim has anyone to sue to prevent damaging a valley down the road apiece? Again the judges have reworked the old rules so that today it is generally accepted that concerned members of the public may participate in agency hearings and may sue to have agency decisions set aside when they do not reflect a proper concern for the environment.

Here we reach the crucial question: do the agencies have to take the environment into account? In one famous case the Federal Power Commission (FPC) was reversed when, upon purely hard-headed economic considerations, it licensed a hydroelectric project that would have destroyed one of the most scenic sites along the Hudson River. The case was significant because it established the right of conservationists to sue. The case was decided against the FPC because the congressional statute that had created the agency had expressly instructed it to take environmental considerations into account, something the FPC had flagrantly neglected to do. What if the statute had not contained that instruction? What would the conservationists, once in court, have talked about? What "law" could they point to in order to fault the agency for its failure to take seriously the environmental consequences of their decision?

This need to find some law that would require an agency to consider the environment arose recently when New Hampshire authorities sought to have a federal court reverse an Atomic Energy Commission decision to license a nuclear power plant along the Connecticut River. Water used to cool the plant would enter the river so superheated that downstream temperature would increase to a point that even warm water fish could not survive. The judicial response was to scan the legislation that created the AEC and to conclude that not only was the agency not required to take the environment into account, it also lacked the authority to require developers to install alternative cooling devices simply to save the environment.

At this point some lawyers, including myself, conclude that the only answer to this conundrum lies in the Bill of Rights. To put it bluntly, there exists a constitutional right to a decent environment, which mandates that every government agency—be it federal, state, or local—cast its decisions so as not to contribute further to the decline of today's environmental status quo. This decision would only operate prospectively and would not extend retroactively. The harm that has already been done can only be undone by legislative action and not by words alone; words alone, however, when they are constitutional law words, are able to ensure that past mistakes will not be repeated.

From whence can this right be derived? This is a horse soon curried. In *Griswold* v. *Connecticut*, for example, the Supreme Court discovered a "right of privacy" inherent in the Bill of Rights, even though that right was not there in so many words. In fact, the long ignored ninth amendment warns us that the listing of rights in the other amendments, such as those guaranteeing freedom of religion and speech, does not eliminate other rights "retained by the people." Manifestly, if the people have the freedom to exercise free speech and to enjoy their privacy, they must also have the right to a decent environment. Why is this clear? Because if we do not have a right to a decent environment, the rest of our rights will prove illusory. We cannot enjoy our other rights if we are all dead. True, this right has never been articulated before, but until the advent of a potentially lethal technological society there was no need to insist upon such a right. Now that there is a potential for environmental disaster, the time has become propitious for the Supreme Court, sensing the felt needs of the time, to implement within the system this fundamental right held by the people. ■

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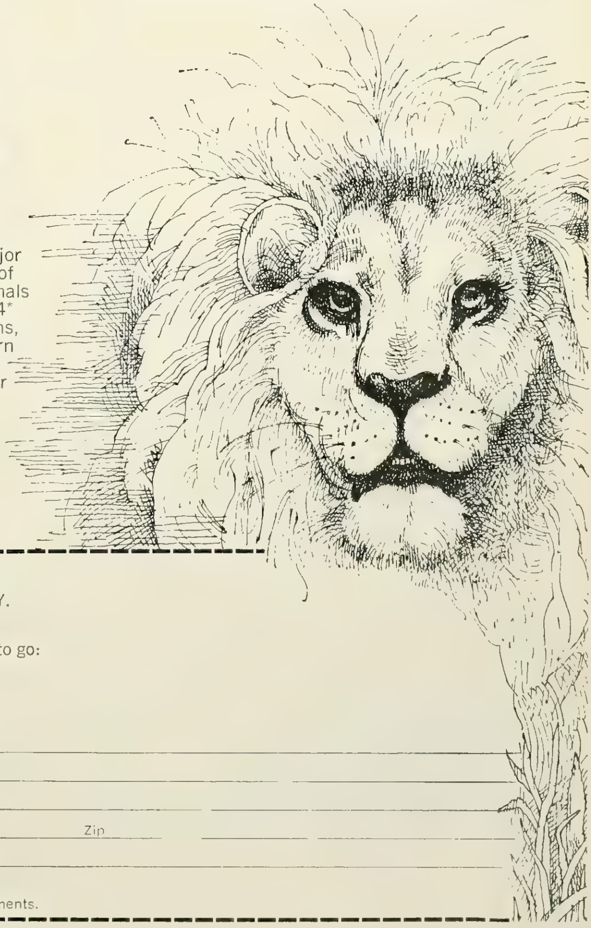

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Death by the Plow

The eastern grasslands of North America, which once occupied large tracts of the Midwest, have vanished—except for a few traces and the haunting descriptions of early settlers

by Richard Brewer

photographs
by Steven C. Wilson

When the first wave of settlers entered the Great Lakes region early in the last century, they found small expanses of grassland scattered through the hardwood forest. These natural communities, up to a few square miles in size, made up only about 100,000 acres in Michigan, somewhat more in Ohio, and still more in Indiana where, north of the Wabash and west of the Tippecanoe, they began to merge into the Grand Prairie of Illinois. These grassland communities also existed in Kentucky and Ontario. Called prairies, barrens, or, where studded with bur oak trees, plains or oak openings, the eastern grasslands were settled early. On the great grasslands farther west, the settlers moved away from the river-fringing forests slowly. The pioneers there feared the prairie fires of the dry autumn, the winter blizzards, and the miasmal wetness of the spring. The prairie sod was hard to break; there were no trees to build with, no acorns for pigs.

The small prairies and oak openings in the Great Lakes region had fewer disadvantages, and the fertile land there was quickly settled and broken. While the sod was not so deep as that of the great grasslands of Illinois, Iowa, and Missouri, the breaking of it with a bull plow—all wood except for the share and colter—and two yoke of oxen was an event that stood out even in lives where exhausting physical labor was the daily routine. The first pioneer to break the prairie never forgot it nor did the community that grew around him. When he died, full of years and honor, his epitaph would include the words, "He plowed the first furrow." Almost none of the prairie escaped plowing and, because it is the best cropland in the region, most of it is still cultivated today.

The natural prairies are gone, or almost gone, but for those who concern themselves with such things, their past locations can be discovered. In the logbooks of the early surveyors, a section corner marked by a stake, rather than by witness trees, or by witness trees of bur oak a chain or more away, usually indicates prairie. On a drive after spring plowing you can still mark the edge of some of the prairies where the black prairie earth gives way to the pale soils that developed under oak forest. The names of villages and landmarks—Flowerfield, Indian Prairie School, Prairie Ronde Township—and, better still, historical records tell where the prairies were when the flood of settlers arrived in the 1820's and 30's.

What the prairies were like is harder to learn. Friends and colleagues of mine have received grants and fellowships to study here and there over the world. For my part, I would like to apply for a Fulbright scholarship to colonial America. There is no other way, I am afraid, to be sure of what the eastern grasslands, or many other communities, were like then. Until my award comes through, we must make do with reconstructions based on the few remaining relicts, on the journals and recollections of settlers and early travelers, and, cautiously, on studies of man-produced grasslands of similar structure.

In some ways the early writings give a clearer picture of the prairies than of the original forests. Prairies were outside the experience of the emigrants and travelers from the forested east and, accordingly, worthy of comment. The historian of Madison County, Ohio, wrote:

"The prairies consisted of level stretches of country covered with sedge-grass, and dotted here and there with patches of scrubby burr-oak growing upon the highest points of land. The sedge-grass grew to an enormous height, sometimes sufficient to hide man and horse when travelling through it. Nearly every autumn prairie fires swept over the country, destroying everything in their path."

The image of a man on horseback hidden by the tall grass recurs in almost every account. The recollection is faithful, but partial. Big bluestem and Indian grass on moist sites, slough grass, bluejoint, and *Phragmites* on wetter ones reached heights of six to eight feet or more; but little bluestem, the dominant grass on the drier prairies, grew only to two or three feet. Even for the moister sites, the image is one of late summer or autumn. Early in the spring the new growth of grass was overtopped by the earliest spring flowers. The tall stalks of the preceding year were flattened and matted by the winter snow or gone altogether, consumed by a prairie fire.

For the identity of the grasses, and of the other plants that grew with them ("The prairies were jeweled with strange and brilliant flowers—'the stars that in the earth's firmament do shine.' "), we must depend on the relict prairies. These are few and small, mostly narrow strips along the rights-of-way of the earliest railroads and on the fringes of pioneer cemeteries. Although they have escaped continuous cultivation, they have suffered many other trials, and probably reflect the original grassland as imperfectly as the pioneer looking glasses, which we now see in museums, reflected the faces of the settlers. Even so, we can learn from them that the low flowers of early spring include such plants as Pennsylvania sedge, bird's-foot violet, and shooting star. Later in the season there are patches of northern bedstraw, erect rather than reclining like most of its relatives, and prairie phlox. These are taller than the spring flowers.

The flowers of July are taller still. Coneflower sends up stalks three or four feet high bearing heads with drooping yellow rays and a brown-black disc. In the same month, wild bergamot is pale lilac; butterfly-weed, a milkweed without milky juice, is orange; and wild indigo, the shrub New Jersey tea, and Culver's root are all white. The settlers used Culver's root to make a decoction for malaria ("We now came to where the water was very bad, the country being flat and the water stagnant. After straining, it would still exhibit live insects, which they call wiggles.").

Later in the summer, goldenrods, sunflowers, and five-foot-tall rosinweeds bear yellow flowers. There are several species of each to be found on the relicts today. Some, such as rigid goldenrod, grow on either wet or dry sites, but others are more restricted. Gray goldenrod, a short plant with dense grayish-white hair, is a part of the vegetation of the drier prairies with bush clovers and Indian tobacco. Riddell's goldenrod, with scythe-shaped leaves folded lengthwise, and giant goldenrod grow in wet soil with rattlesnake-master and closed gentian.

In September and October, when the big bluestem is tall and bearing its turkeyfoot racemes, the asters and blazing-stars close out the season. The bur oak leaves turn to reds and browns. Some fall with the first frosts, but others hang on, dropping a few at a time through the winter.

The relict sites are too small to provide testimony on the animals, except possibly for some of the invertebrates and small mammals. The prairie vole, for example, can still be taken on some sites, but the runways in the bluegrass of the surrounding countryside are those of its relative the meadow vole. From historical records we know that deer were present. A winter traveler in Calhoun County, Michigan, wrote:

"But, lost as I was, I could not help pausing frequently when I struck the first burr-oak opening I had ever seen, to admire its novel beauty. It looked more like a pear-orchard than anything else to which I assimilate it—the trees being somewhat of the shape and size of full-grown pear trees, and standing at regular intervals apart from each other on the firm level soil. . . . Here, too, I first saw deer in herds; and half-frozen and weary as I was, the sight of the spirited-looking creatures sweeping in troops through these interminable groves, where any eye could follow them for miles over the smooth snowy plain, actually warmed and invigorated me, and I could hardly refrain from putting the rowels into my tired horse, and launching after the noble game."

From similar accounts we know that there were bison and elk, although these were all but gone by the time the settlers arrived. There were badgers, and a few survive today, not on the prairies, but here and there in the less frequented parts of the countryside where they have managed to escape the attention of man. The massasauga is now a bog species for the same reason; in early times it was common on the prairies ("We camped out two nights . . . and slept without any apprehension, except from the prairie rattlesnake, a small but very poisonous reptile, frequently to be seen in these parts.").

The gray wolf roamed both the prairie and the forest; stories, possibly slightly enhanced in memory, of nocturnal encounters with wolf packs form substantial portions of the published recollections of the pioneers ("Coming to a tamarack swamp we made up our mind our only salvation was to strike a fire, for the wolves were on our track and when darkness fairly set in an attack was certain.").

The pioneers had little to say about birds, although as early as 1838 a catalog of the birds of Ohio was published by Jared P. Kirtland and a year later, one for Michigan by Abraham Sager. The relicts are not very informative either; the birds that visit the narrow strips are mainly those that nest in the adjoining vegetation. There is, nevertheless, a fascination in trying to reconstruct from knowledge of the present-day habitats of birds and from limited historical information what the bird community of the early grasslands might have been like. If I were the man on horseback, what birds would have been singing about me in the summer or swirling across the snowy plain ahead of me in winter?

For the last eight years I have studied an area of about 40 acres of unmowed hayfield in Kalamazoo County, Michigan. The plants of this grassland are not prairie plants; there is brome grass instead of bluestem and alfalfa instead of beach-pea or bush lespedeza. But in other ways—general structure and appearance, the amount of new plant material produced in a season—the resemblance is tolerably close. In this area, the most common bird species are red-winged blackbirds, Henslow's sparrows, bobolinks, Eastern meadowlarks, Savannah sparrows, ring-necked pheasants, short-billed marsh wrens, and dickcissels. This provides a starting point that can be checked against other sources.

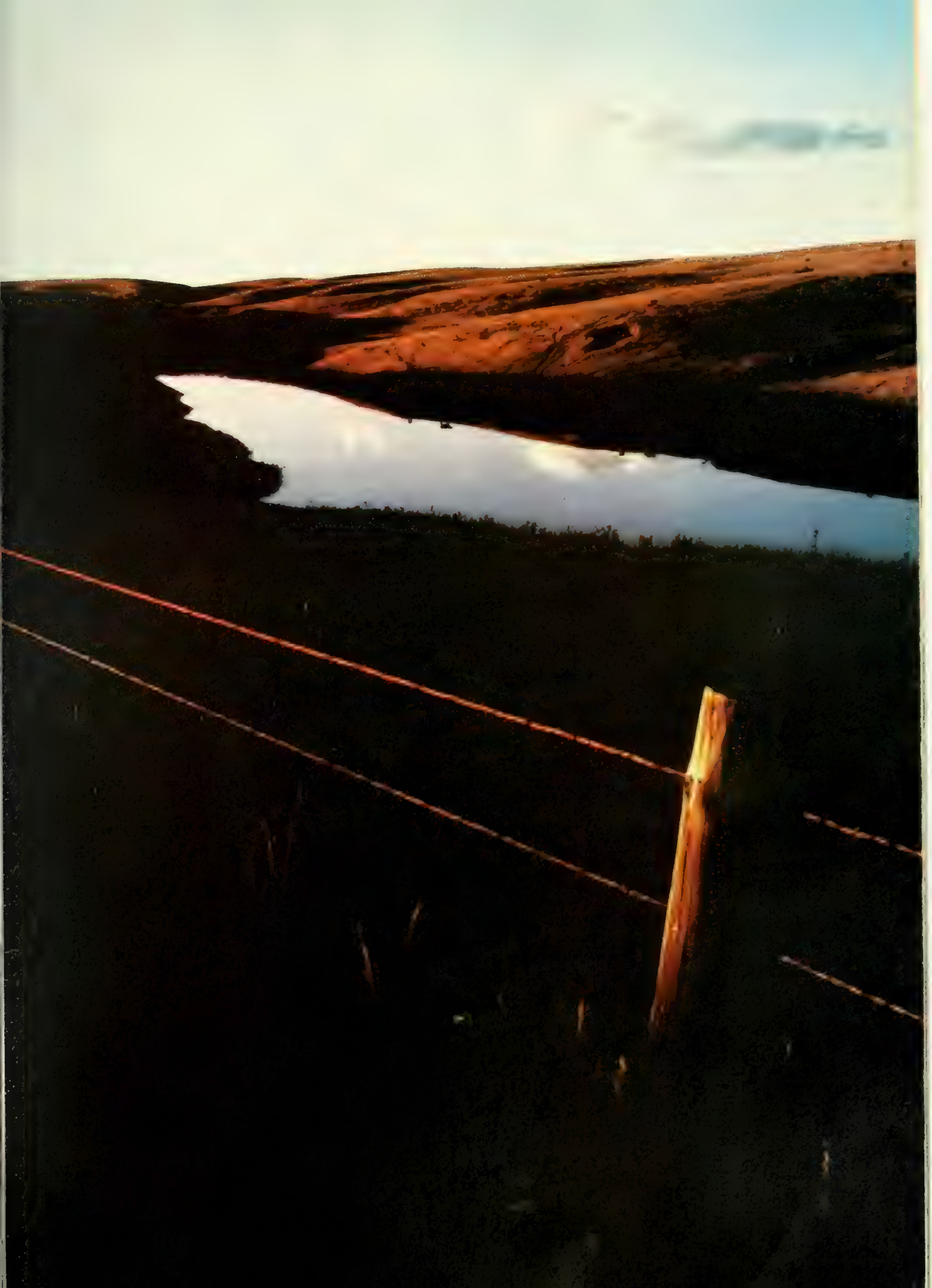
A paper read by L. Whitney Watkins before the second meeting of the Michigan Academy of Sciences in 1895 deals with birds of open country and is one of the first papers written on the subject of bird communities. We do not need Watkins to tell us that the introduced ring-necked pheasant would have been absent in earlier times, but he does confirm that in place of the pheasant there were probably bobwhites on the drier sites and prairie chickens on the moister ones. He indicates also that the red-winged blackbird was probably all but absent from the original grasslands ("once found to leave its customary reeds and cattails in the bog and build its nest in a tuft of grass in an open marsh"). From this source and others are derived the following lists, which represent my best answers—or guesses—to the question of what birds characterized the eastern grasslands 150 years ago:

Summer	Winter
Mallard	
Swallow-tailed kite	
Red-tailed hawk	Red-tailed hawk
	Rough-legged hawk
Marsh hawk	Marsh hawk
Sparrow hawk	Sparrow hawk
Prairie chicken	Prairie chicken
Bobwhite	Bobwhite
Sandhill crane	
Upland plover	
Mourning dove	Mourning dove
	Snowy owl
Short-eared owl	Short-eared owl
Nighthawk	
	Horned lark
Short-billed marsh wren	
Loggerhead shrike	Northern shrike
Bobolink	
Eastern meadowlark	
Dickcissel	
	Common redpoll
Grasshopper sparrow	
Henslow's sparrow	
Vesper sparrow	
	American tree sparrow
	Lapland longspur
	Snow bunting

Some of the birds listed did not restrict their movements to the prairies. The mallard female nested there within walking distance of water; the sparrow and red-tailed hawks nested in trees but searched the prairies for mice or grasshoppers. Having included these species, we might well include several others: where a bur oak provided a suitable nest site, eastern kingbirds would be a part of the community, and in the shrubbier areas with gray dogwood and prairie willows, there would be song sparrows or field sparrows.

Some of the species deserve further comment. What of the swallow-tailed kite, now a scarce bird of southern swamps? According to Kirtland, it was present on the prairies of Ohio where it fed on snakes and frogs, but disappeared quickly as the land was broken. Farther south on the small prairies of Kentucky, southern Illinois, and Indiana, the Mississippi kite also was present. Robert Ridgway visited Fox Prairie, Illinois, in August, 1872:

"As we came well out on the prairie, a beautiful and unlooked-for sight appeared; in short, we were completely transfixed by the to us novel spectacle of numerous exquisitely graceful swallow-tailed kites floating about on buoyant wings, now gliding to the



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right or left, then sweeping in broad circles. Soaring lightly above them were many Mississippi kites, of which one would now and then close its wings and plunge downward, as if to strike the very earth, but instantly checking the velocity of its fall by sudden spreading of the wings, would then shoot upward again almost to the height from which it had descended. When two or more passed one another at opposite angles—as frequently happened—the sight was beautiful in the extreme."

Ridgway visited the prairie again, twelve years later: "The change which had taken place in the interval was almost beyond belief. Instead of an absolutely open prairie some six miles broad by ten in extreme length, covered with its original characteristic vegetation, *there remained only 160 acres not under fence*." The kites were gone.

Some open country species, however, increased or even invaded the region as the forests were cleared and pastures and fields of row crops spread over the land. The horned lark may have been one of these in the easternmost prairies. I have listed it only as a winter resident, represented by the yellow-browed northern subspecies that came down from Canada to

feed in the sparser grasslands and along the lake shores. The prairie subspecies that now nests in the region may not have arrived from the west until after man had opened up the country. Another grassland bird not originally present may have been the Savannah sparrow. According to Morris Gibbs, a physician who prepared the first list of birds of Kalamazoo County, Michigan, the sparrow was unknown there until 1873 or 1874 and was not yet known to nest in the county in 1885 when Gibbs prepared his catalog. From Michigan it moved southward, reaching northern Ohio sometime after 1903.

Other species may belong in this same category, but the absence of a species from the early lists is not always evidence that it was not present. None of the early lists, for example, includes the Henslow's sparrow, but it is easy to see how that inconspicuous, almost inarticulate little bird could have been overlooked. I would guess that its strange evening chorus of hiccup-like notes was the one most characteristic sound of the eastern prairies, more so than the booming of the prairie chicken, the trill of the short-billed marsh wren, or the bubbling, tinkling flight song of the bobolink.

In the winter, I often walk from one end of the hayfield that I study to the other without raising a bird. Much the same must have been true of the prairies. I once saw a flock of snow buntings, several thousand, that had spent the winter on Prairie Ronde, in Michigan, feeding in fields of unharvested sorghum and, with horned larks and Lapland longspurs, in pigpens and on recently manured fields. As I watched the sight, I imagined that I was seeing what a pioneer on Prairie Ronde might have seen 140 years ago. Snowflake is the old-time name for the snow bunting, and at times so many birds were in the air, swirling and flashing white, that the flocks did look like blowing snow. But then I walked along an abandoned railroad right-of-way where a few patches of prairie vegetation still grow. The snow was deep, and the only food to be seen was a sparse selection of goldenrod and aster fruits of little food value and coneflower and sunflower fruits which, from their size, may be a little more nourishing. If such flocks lived on the early prairies they must have moved often, as they exhausted the food, and after they had gone, the plains must have seemed even emptier.

The treelessness of the prairies puzzled the early travelers and naturalists. Why should one piece of land support prairie while another, not far away, held maples and beeches with trillium and Solomon's seal in the shade below? Many answers have been proposed. The dense prairie sod, wet in spring and dry in autumn, is a poor seedbed for trees. In many trees the roots must join with fungi in unions called mycorrhizae to function well; possibly these fungi were absent from the grasslands. The climate of the region where the eastern prairies occur is peculiar, with a strong tendency towards drought and high temperatures in the summer. Fires favor grassland over forest. A fire sweeping through the dry grass of a prairie at the end of a growing season does little harm to the grasses; indeed, they may well make better growth the next year because of it. But a small tree, the result of several seasons' precarious survival, will probably be killed. After Indian fires were stopped, the pioneers saw enough instances of trees invading grassland to convince them that burning was important in the maintenance of many grasslands. In the oak openings region, the Indian word for fire, *scutay*, or *sco-tay*, also meant prairie.

The ability of grassland to resist the encroachment of forest is probably explained by some combination of these possibilities, but they do not get at the question of how prairie came to be there at all. There is still no completely satisfactory answer to this problem, but it is clear that the answer, like many answers in ecology, must consider history as well as contemporary environment. One possible reconstruction goes something like this:

When the last glaciers of the Wisconsin period left the region some ten or fifteen thousand years ago, pioneer plants invaded the bare glacial drift. Under the cool, moist climate that prevailed as the glaciers wasted away to the north, tundra and then a forest of spruce and fir developed. A long, warm period followed, eliminating the spruces and firs. They were replaced by trees adjusted to warmer conditions. The warm climate became increasingly dry. In this xerothermic period dry forests and grassland expanded at the expense of other vegetation. Grassland and the animals associated with it pushed eastward and sent a peninsula of prairie to Ohio and beyond. More recently, the climate has become cooler and moister. Botanists studying the fossil pollen of northern bog lakes find an increase in the pollen of trees of cool, moist conditions. The grasslands and dry forests apparently shrank as the forests made up of these trees expanded.

One point of debate is, when did the eastward migration of prairie species occur? Much of the movement may have been in a postglacial xerothermic period as in the reconstruction just given, but there are at least two other possibilities for which support can be found. It is possible that the open vegetation that

Continued on page 110

Base (0-15 seconds): (1) RP3, p3 (2) RP4, beh p3 (3) RP4 fr. wind. STIM. 15 sec.

Response (15-60"): (1) no resp. (2) sp2, alert, ho, cr2 dart Ep3

Return to normal (5-6 minutes): (1) Th, pu (2) Th (3) N (3) lv p3, ho cr2 (1) MD (2) MD (1) Th, Th (2) desc RP3, beh p3

Or:

THREE FLEEING BULLHEADS

by John Bardach and Trudy Villars

The strange code at left is an almost direct transcription of the behavior of a bullhead (*Ictalurus natalis*) community of three, after the introduction of an alien smell into their tank. The base is background information: all three fish are quiet, on the bottom of the tank (RP—resting position) each in its own territory or shelter, (either inside a broken clay flower pot p3—pot #3), behind the pot (beh p3), or at the front of the tank (fr. wind). Upon introduction of the smell (STIM.) all show signs of anxiety by "breathing" harder (sp—stress pump), and of alertness by hovering, cruising, and then darting into the safety of the central clay pot (Ep 3—enter pot #3). Five minutes later, as their fear diminishes, the original resident of the central pot ejects the two sudden visitors with some mild threats: Th, thrust; N, nip; pu, push; and MD, mouth display. They leave (lv) and return to their original positions.

Olfactory acuity in fishes is remarkable. The late Harold Teichmann trained small eels to detect phenylethyl alcohol at a concentration so low that only one or two of the alcohol molecules could be found in the animals' nasal chambers when they responded.

Another fish with a keen sense of smell is the skipjack tuna, a fast-swimming predator well capable of using olfaction to approach its prey. We tested tuna scent-tracking methods and found that when a cupful of water in which a specimen of their customary prey had resided for about a minute was poured into their large circular basin (the volume of about a tank car), the tuna began a frantic search. The number of scent molecules available to the tuna must have been about the same as in the case of Teichmann's eels.

Fishes are able to detect extremely dilute concentrations of an olfactory stimulus, but this does not necessarily mean that they have the ability to make fine distinctions between slightly different smells; they may be sensitive to only a few substances. Observations by a student of Von Frisch, however, indicate otherwise. W.L. Wrede noted that different fishes smell differently, even to us, as anyone can test for himself when he sniffs at a freshly caught carp, a sunfish, or perhaps an eel. She demonstrated that fish also can distinguish several species of fishes by smell. Another student of Von Frisch then demonstrated that the small minnow *Phoxinus* could be trained to recognize by smell individual members of its own species.

For some fish, at least, olfaction appears to be a very sensitive and discriminating sense. Yet, as we tried to determine how the bullhead locates food, it became apparent that smell didn't seem to be involved at all; the fish proved to us that they could locate food solely by taste. They are unusually well fitted for gustatory searching because they have tens of thousands of taste buds all over their bodies, especially concentrated at the tips of their barbels—the long, slender projections from their lips.

Serendipity led us to determine exactly what the nose does for our bullheads. Hundreds of tanks in our laboratory serve as temporary homes for the fish. Some contain several small fish, while others hold one large, tough old fighter. One evening, two neighboring tanks were not completely covered. One of these tanks had three medium-sized, sleek bullheads, which had formed a stable community for temporary coexistence. The other tank contained one large fish. The next morning the tank with the three fish was empty, while the tank with the solitary inhabitant was the scene of nocturnal mayhem. The three smaller fish had jumped into their neighbor's tank and had been severely beaten. We returned them to their original tank, and after they recovered they resumed their communal existence. Several days later a small beaker of water from the tank in which they had undergone their traumatic experience was gently poured through the water filter of their tank so that the visual and vibratory clues would be eliminated. After a few seconds, terror struck the three fish. Each darted, apparently in extreme fright, to its respective shelter in its own territory. This was a highly specific response to some chemical stimulus, through either smell or taste. We remembered that the earlier German experiments, as well as our own, had shown that gustation was clearly involved in food search, even though smell is the keener sense. Therefore we followed the hunch that smell, rather than gustation, was the key to this kind of social response.

Although there is much research on olfaction in fishes, especially its function in detecting food and in the homing behavior of such fish as salmon, its role in their social, or even sexual, behavior is still relatively unknown. Our observations encouraged us to examine the nature of the chemical stimulus of smell. What kind of compound is it, is it soluble or volatile, what relation does it bear to commonly encountered, or specific, rare chemicals in the environment, and what is its source? We were also interested in the role of the receptors and central nervous system in behavior.

In fish, as in other vertebrates, smell and taste are two separate channels for the reception of chemical stimuli. Each reacts to a different category of stimuli (although there is some overlap; for example, certain amino acids are both smelled and tasted). The taste capabilities are restricted to the conventional sweet, salty, sour, and bitter soluble compounds, with some peculiar permutations and combinations of these basic categories. Compounds that fishes smell belong to a variety of chemical substances, mostly volatile.

In analyzing the role of these chemical substances in behavior we used two basic experimental methods, behavioral observations and conditioning. The behavior code that begins this article is an example of how the observations were recorded, using a table of 56 behavioral units prepared by fellow researcher John Todd. These units can be roughly classified into a feeding group, a social group, and a neutral group. The following, condensed table describes some of the more important units in the social and neutral groups. With this shorthand system we documented observations of the fishes' reactions to their customary tankmates or to a strange fish.

NEUTRAL:

(cr) Cruise: neutral swimming.
(E) Enter: going into a shelter.
(ho) Hover: being suspended in one place, with slight fin and tail movements.
(RP) Resting position: parts of lower side of fish resting on bottom.

SOCIAL:

(ap) Approach: cruising toward another fish.
(av) Avoid: turning and cruising away from another fish.
(Bi) Bite: long mouth contact with other fish, frequently gripping the other with his jaws.
(MD) Mouth display: mouth opened threateningly, resembling a "silent roar."
(MF) Mouth fight: two fish grab each other by the jaw and tug at one another violently.
(RP5) Resting position 5: last in a series indicating closeness to substrate. An escape behavior visible only in defeated fish in which it appears to cringe and attempts to melt into the bottom.
(sp) Stress pump: high intensity breathing, indication of "anxiety" or stress.
(Th) Thrust: lateral head and body swings aimed at the opponent.
(WP) Window push: escape behavior in which fish pushes his nose vigorously against the window.

After observing small communities of these catfish we soon suspected that the bullheads recognize each other as individuals. There is a regularity in their reactions to one another and each fish's response patterns vary with the individual to which it responds. For example, a fish whose rank in the tank is about in the middle will avoid those fish that have proved to be stronger. When they approach he might flee or hover in a weak, defensive position calculated to appease his opponents. This same fish, however, might show a great deal of aggression toward a smaller fish less capable of defending itself. These patterns are highly consistent, so much so that it is usually possible to identify a fish by its behavior toward another fish; even slightly changed patterns are quite noticeable.

Observations of numerous bullhead communities revealed (1) that bullheads recognize as individuals other bullheads with whom they share a large tank, (2) that it is primarily the nose and therefore the sense of smell that mediates this recognition, (3) that there is an adaptive advantage for fishes of such home range habits as the bull-

head in recognizing its neighbor, and (4) that an adverse experience such as a fight changes an animal's odor, and after an encounter he is not recognized any more by members of a community with whom he had previously established stable relations. Proof that recognition is dependent upon olfactory, not taste, input was obtained by means of conditioned reflex training of certain bullheads. Todd simulated, under controlled conditions, the situation that had first made us note the involvement of smell in social behavior, namely, clear-cut reactions—in the absence of visual or tactile clues—to the water from the tanks of other fishes. Tiers of aquariums held test fish and smell donors in solitary confinement. The test fish were trained with food reward and electric shock punishment to discriminate between the tank waters of two donors. When the olfactory epithelium of a trained fish was destroyed by cold cautery, however, it was no longer able to discriminate between the tank waters, a good indication that the distinction was dependent on smell.

The reaction of the test bullhead to the tank water paired in reflex training with electric shock was one of flight, with occasional elements of mild aggression. This is reminiscent of the behavior of the second or third ranking member of a three-fish community of untrained fish.

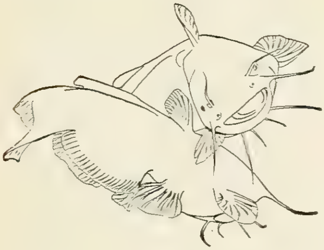
The response of a bullhead to an unknown bullhead is outright aggression, but attacks against familiar fish, when they occur, are less intense. Using aggression as a measure of recognition, Jelle Atema, another researcher working with us, found that interference with olfactory input resulted in increased aggression against both known and unknown fish.

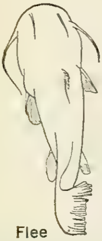
Aggression is an emotional response controlled in mammals and man by the limbic system, a set of ganglia and their converging neurons interposed between higher and lower brain centers. This system is analogous to the fish forebrain, the area most prominently involved in fish smell. It may be coincidence, but interesting nevertheless, that in bullheads interference with smell or the forebrain promotes aggression.

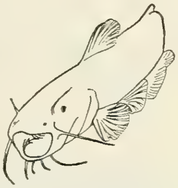
There are three characteristics that might account for the unique odor of a fish. These are its slime (continuously produced by mucous glands in the skin), its urine, and its feces. All three enter the water. Of these, slime and urine are most likely to change with different con-

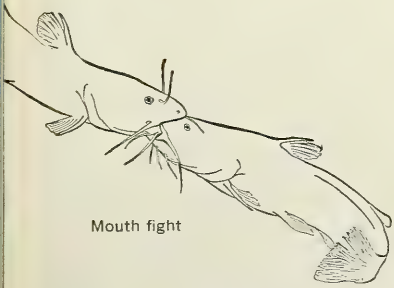
A bullhead fight: fish at top aims lateral head and body swings (thrust behavior) at an intruder.

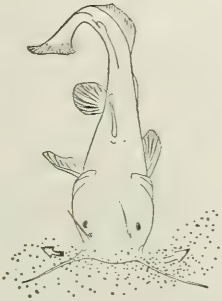
CHARACTERISTIC BULLHEAD BEHAVIOR


Mouth display and thrust


Flee


Chase with mouth display


Mouth fight


Dig and headstand

ditions, such as trauma, that the fish encounters. The appearance of stress products in fish urine after exposure of the fish to oxygen deprivation or temperature shock has been reported.

We believe the urine is only a minor factor in recognition by smell because of strong evidence that the slime is the prime contributor. Pat Dubowey, a graduate student in our lab, trained each of several bullheads to recognize the difference between the slime of specific other bullheads. She carefully rinsed the animals with neutral water and then swabbed the slime only from the dorsal region of the donors. The cotton wool swab was rinsed into a beaker so that the slime-containing water could then be used as stimulus. Because the slime was taken from the donor's back, far from the vent, urine was ruled out as a contributor. The experimental subjects learned well to discriminate between the slime of two donor fish (as Todd's fish had learned to discriminate between the waters in which two donor fish had resided). However, when she subjected her donors to forced hostile encounters by introducing them into a strange tank, the slime collected from them for a day or two after the encounter was not recognized by the experimental subjects.

Assuming that recognition by smell is based on a specific chemical signature, it is to be expected that this signature is blurred or altered because of stress-product-induced changes in the metabolism of the animal after a fight. A small number of distinct chemicals, perhaps three or four, would be enough to give each fish its chemical signature, provided the chemicals occur in distinguishably different amounts in the slime of each fish. Nonrecognition following stress may be the result of the addition of a compound (or compounds) not present before, or it may be caused by an alteration in the levels of previously present components. Nonrecognition may simply be caused by the greatly heightened production, under stress, of one of the components of the smell, similar to certain insects where a pheromone at a low concentration initiates aggregation and at a high concentration, flight.

The existence of chemical communication in aquatic animals by means of social pheromones is one of those subtle evolutionary adjustments to a complex ecological situation that may well be upset by man. Man-made additives to natural waters can stop chemical recognition in two ways. Some compounds, such as detergents and possibly hydrocarbon insecticides, depress or eliminate the function of chemoreceptors. Other compounds may act as pheromone analogues or interfere with a pheromonal code. Thus, messages may not be received or their meaning may be altered. These are sublethal pollution effects. They do not kill the animals, but they confuse them so that they cease to behave normally. Eventually fish may be decimated in this manner just as effectively as if they had been poisoned outright.

Originally, our bullhead research was specifically directed to the chemistry of smells, the physiology of olfaction, the interpretation of scents by the central nervous system, and species specific behavior. As we proceeded we realized that this research applies to a very subtle aspect of pollution, the interference with natural smells by man-made ones. We now have at least the technical, if not the social, know-how to deal with the massive addition to our waters of domestic effluents or most industrial poisons, but alleviation of sublethal pollution effects requires more knowledge than we presently possess. We hope that our research findings have at least made a beginning toward understanding and consequently repairing some of the damage man has unwittingly wrought in aquatic ecosystems.

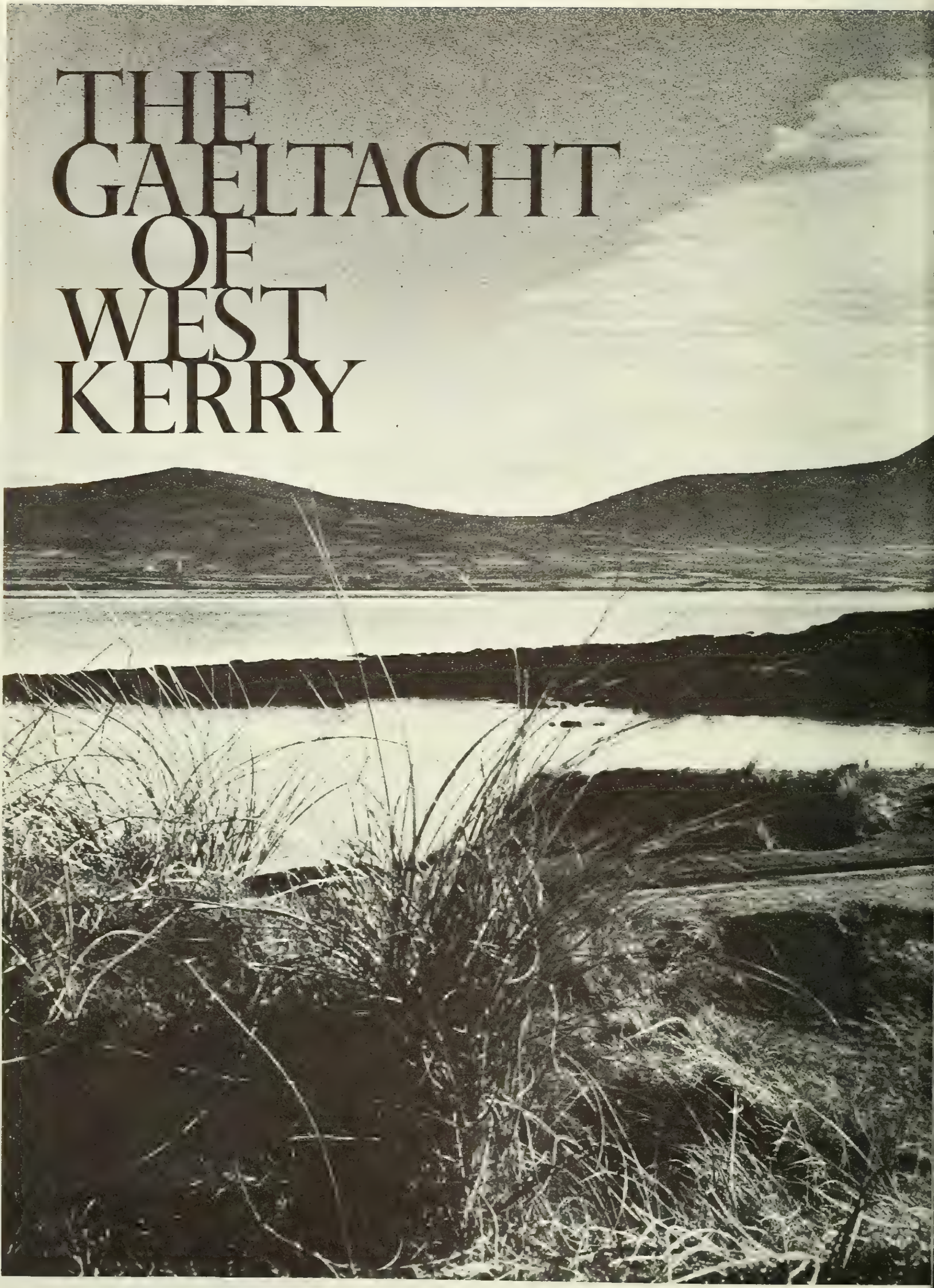
Refuge in a flowerpo
two small bullheads take cov
in another's shelter aft
detecting an alien sme

The life here is not dramatic on the surface; we don't go down to the sea in currachs, we only go to the creamery with the horse and cart. There are no great forests here or no great lakes or no great deserts to feed the imagination. There are no earthquakes or great floods or hurricanes to remind us that life is wonderful and terrible. It is a land of little fields and of people who lead what seem to be uneventful lives. You think about "the long littleness of life" and in infertile moments you say to yourself "that's this place, all right." But in your secret heart you know you are wrong. You know that under the accretions is the profound life, almost smothered by the inhibitions engendered by a land where there is so little spiritual room, almost worn away by the attrition of living, but always alive and now and then reaching the surface.

Human nature may be the same from China to Peru but the life of a place is powerfully influenced by the shape of the landscape, the color of the sky, the sun and the rain, the history of the people. The life takes on its own unique texture.

Words of a Kerryman

THE GAELTACHT OF WEST KERRY



PHOTOGRAPHS BY LISA STEPHENS

The rocky Dingle Peninsula of West Kerry juts out from southwestern Ireland into the purple-blue Atlantic Ocean. At the tip of the peninsula, west of the main town of Dingle and over the windswept mountains, lies a stark, rugged plain of some 100 square miles that slants down to the sea. On this gray land, beneath looming Mount Brandon, a few thousand Irish live on scattered farms and in small hamlets of the parishes of Ballydavid, Ballyferriter, and Dunquin.

The whole fabric of their lives contains many threads of the old way. The people speak Gaelic, the ancient language of Ireland. They live off the land, subsisting mainly on the crops they grow, with a small cash income from the sale of fresh cream and livestock. The rhythms of their daily and yearly lives follow the changing seasons.

When winter comes in November, the wind blows in hard off the Atlantic, past the great headlands of Brandon, Sybil, and Slea, bringing cold rain and sending life inward. Except for trips to the creamery, little is done outside the wall that encloses the haggard, or farmyard, and shelters both men and animals. The men patch and repair equipment, rebuild walls, spread sand over the mud paths and shed floors. The women, caught in a dawn-to-dark cycle of cooking, baking, milking, knitting, mending, washing, feeding chickens, and other chores change their routine little throughout the year. "One woman in the house," suggests an old proverb, "should be always working." The easing of field chores enables the farmer to take part in the annual holiday season, from Advent, the fourth Sunday before Christmas, to Epiphany, January 6. Then the farmer begins his annual work again: planning the spring planting, cleaning out ditches and drains on clear days, preparing seeds. The talk at night around the turf fire is about the fields, the crops, calving.

The farmer's spring begins on St. Bridget's Day, February 1. Hard, clear days occasionally break the winterlong monotony of almost constant rain and clouds. The wet, brown fields, coated in the fall with kelp, begin to dry. In February and March the farmer tills the field, plants potatoes and mangles, and then sows the wheat and oats. In spare time the kitchen garden is turned over and planted with cabbage, onion sets, and other vegetables. Within the haggard, the pace quickens, too. The newborn piglets, lambs, and calves must be tended. Milk production increases, and cows are milked twice a day. The evening milk is set aside in cans for the morning delivery by horse-drawn cart to the cooperative creamery. No refrigeration is needed because the sea winds are always cool.

By May, as the weather grows warmer and the number of sunny days increases, the bogs have dried out enough for the annual digging of the peat. Pushing on his sharp-edged *slán,* the farmer slices neat rectangular clumps of peat from the bog and stacks them carefully in piles to dry out in the summer sun. The first vegetables are taken from the garden, bringing a welcome change to the winterlong staples of potatoes, bread, milk, eggs, bottled cheeses, and canned beans.

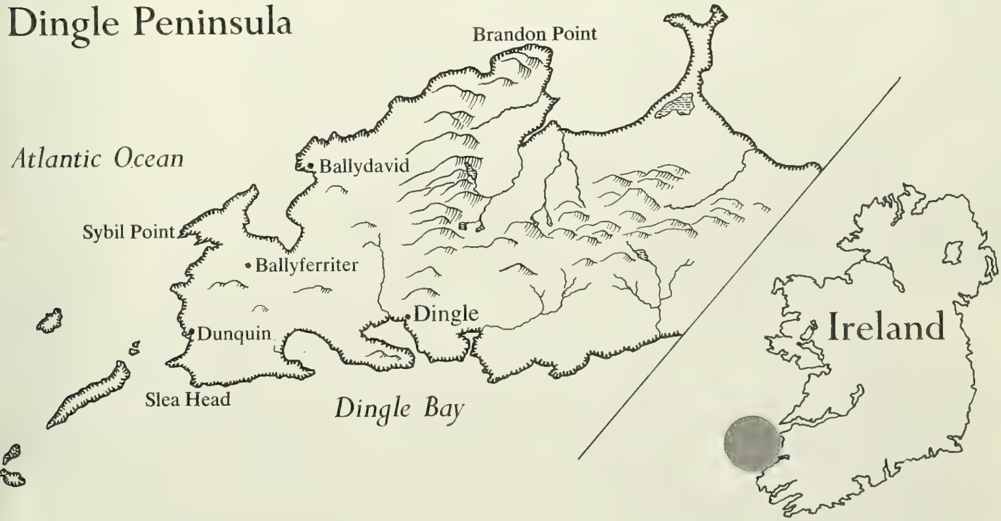
The main harvest begins in late July or early August, when all thoughts and energies are directed to gathering first the hay, then the oats. The harvest is always a race against the wet weather that comes in early fall.

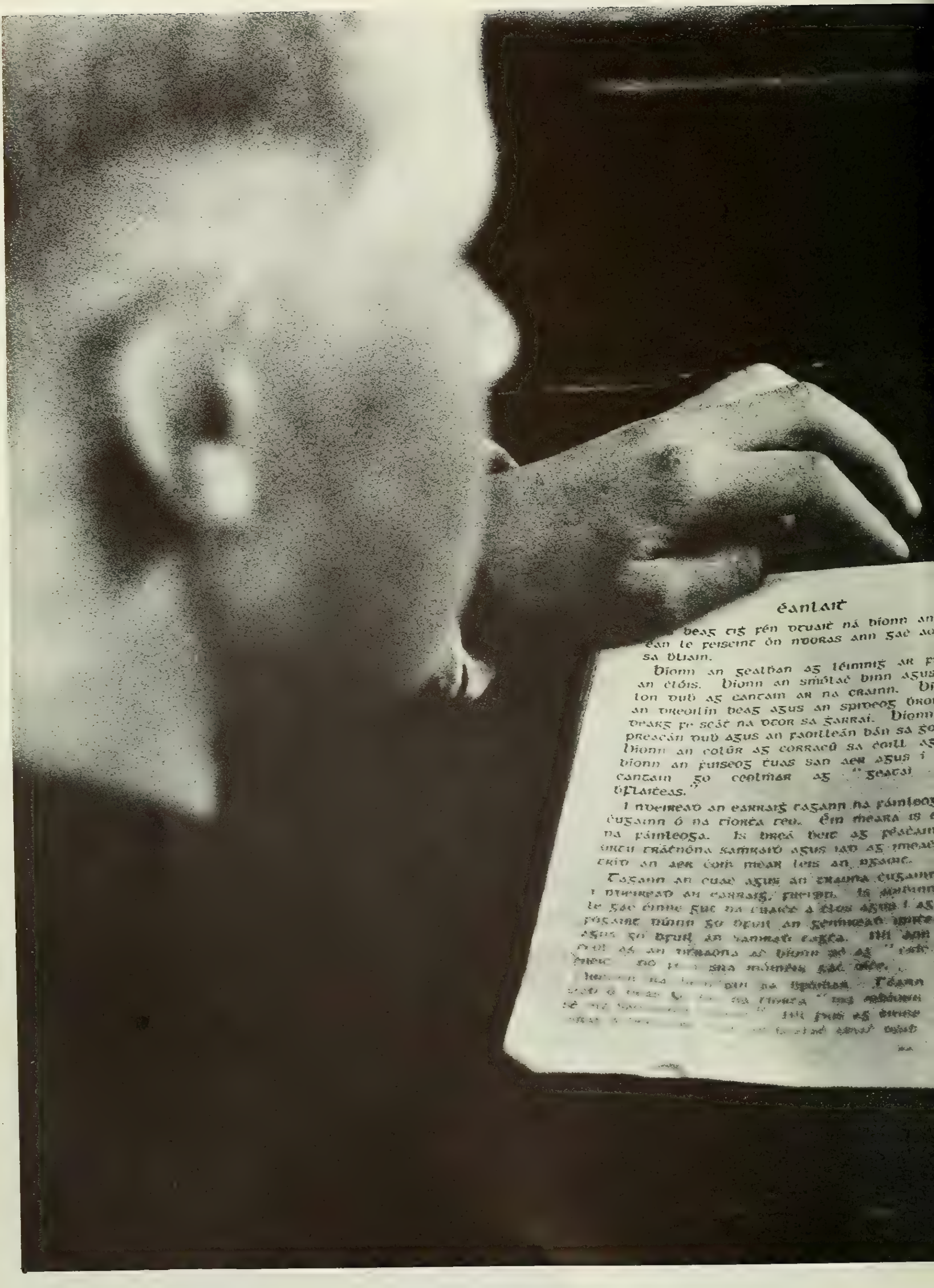
From September through November, life ebbs back to the haggard and the house. The hay is brought into the haggard and carefully stacked in the great hayrick. Turf, dried by the brief summer sun, is brought down from the bog ricks to the farm. The root crops are pulled, sorted, and stored. The day shortens, the weather worsens, and life turns inward again. The men gather in the evening at certain farmhouses or at small crossroads pubs to talk, to listen to the radio, to play cards.

For the children, who participate in the daily and seasonal tasks, the compulsory primary school imposes another pattern on their lives. Many walk miles every day through sodden fields, over bracken-covered hills, and down boreens to reach the paved road leading to the single parochial school in each parish. While most children end their formal education with primary school, a few go over the mountain to the secondary school at Dingle, but the difficulties of travel and the fees, although small, put this level of education beyond the means of the average family.

The cold, dark month of December is a holiday period. Children are home from school. Preparations are made for holiday meals. Young people play the accordion, as their elders played the fiddle. Families sing and listen to stories, although the great storytellers are disappearing along with the fiddlers—both seemingly replaced by the radio.

Early on the day after Christmas, called The Day of the Wren, groups of young and old, wearing costumes and masks, go from door to door asking for money. They carry musical instruments and sing songs. As the day continues, they work their way into Dingle, where the celebrating continues far into the night. This traditional day of public ribaldry, so unlike the other 364 toil-filled days of the farmer's year, is strangely appropriate. It symbolizes the struggle of men who, by persistently clinging to an ancient language, to a poetic speech, to stirring songs, and outlandish symbols, demonstrate that the human spirit can prevail.


Dingle Peninsula
Brandon Point
Atlantic Ocean
Ballydavid
Sybil Point
Ballyferriter
Dingle
Dunquin
Slea Head
Dingle Bay
Ireland



Éanlaiṫ

beag tiġ féin dtuaiṫ ná bíonn an
éan le feiscint ón ndoras ann gaċ
sa bliain.

Bíonn an gealḃan ag léimniġ ar
an ċlóis. Bíonn an smólaċ binn agus
lon dub ag cantain ar na crainn. Bí
an dreoilín beag agus an spideog bro
dearg fé scáṫ na dtor sa ġarraí. Bíonn
preaċán dub agus an faoileán bán sa go
bíonn an colúr ag corraċú sa ċoill ag
bíonn an fuiseog tuas san aer agus í
cantain go ceolmar ag "geataí
bflaiṫeas."

I ndeireadh an earraig tagann na fáinleog
ċugainn ó na tíorṫa teo. Éin mheara is
na fáinleoga. Is breá beiṫ ag féaċain
orṫu tráṫnóna samhraiḋ agus iad ag imeaċ
tríd an aer ċoiṁ mear leis an ngaoiṫ.

Tagann an cuaċ agus an traona ċugainn

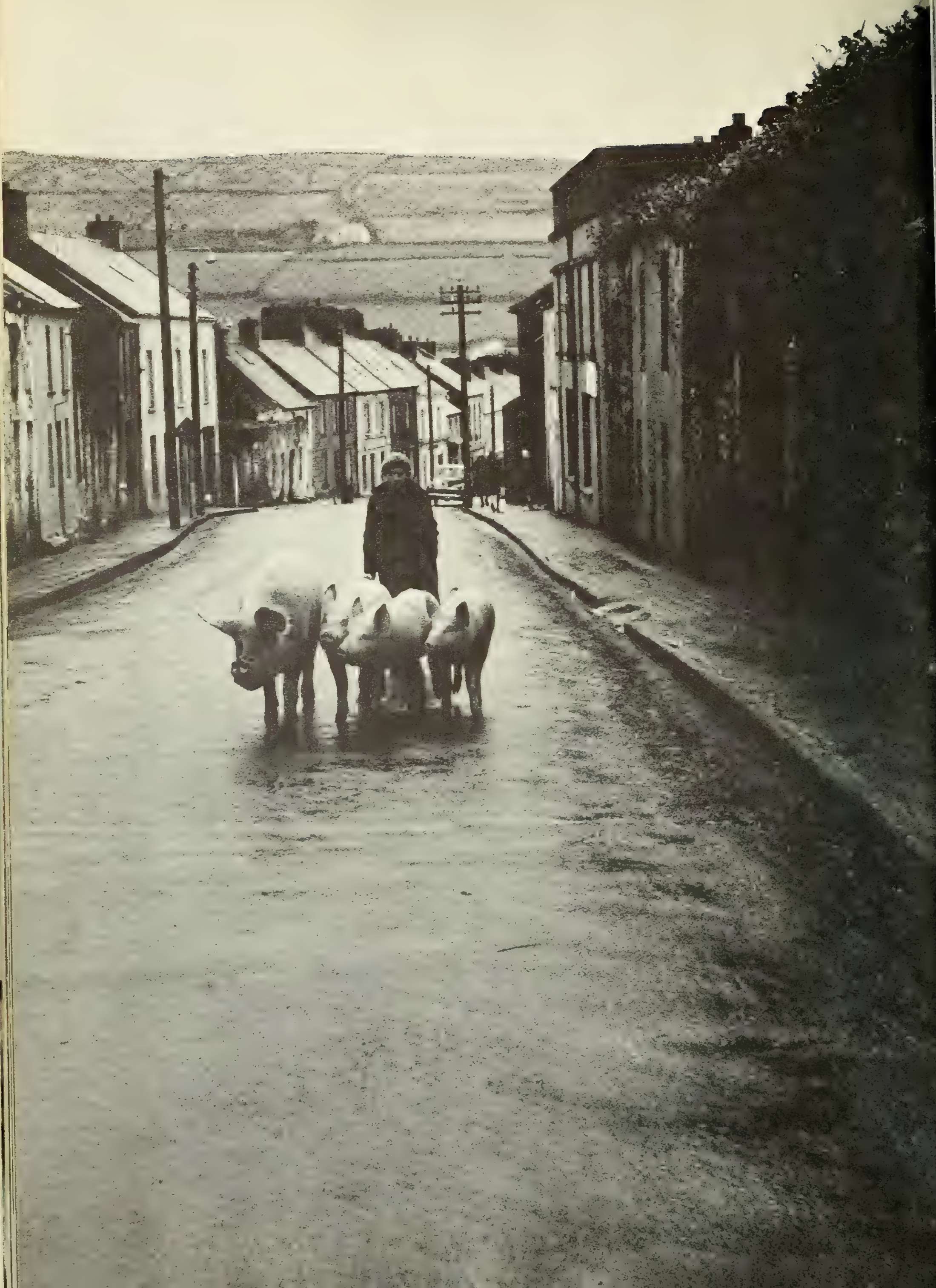
féin na céadta míle ... na
Is é Dia na Glóire féin, molaḋ go
a stiúraíonn iad.

"Feaċaiġí éanlaiṫ an aeir," ar Se
"ní ċuireann siad síol, ná ní ḃaineann
fómar, ná ní ċnuasaíonn siad i
agus deineann ḃur nAṫair neaṁḋa
coṫú."

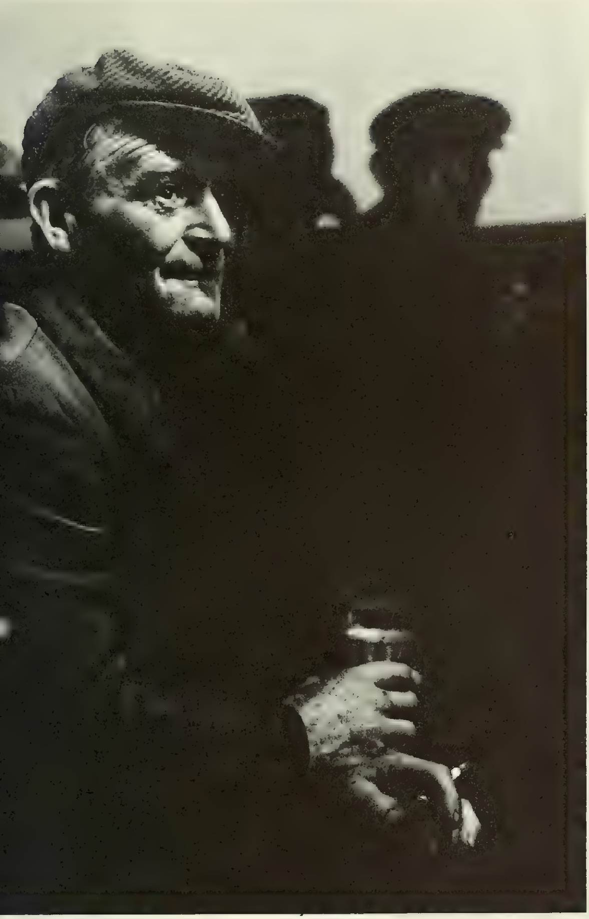
MO ĠRÁ

Mo ġrá-sa Dia an tAṫair,
Ḋein talaṁ, muir is spéarṫa,
Mo ġrá-sa Íosa, a Ṁac san,
Fuair bás, cun sinn a ṡaoraḋ

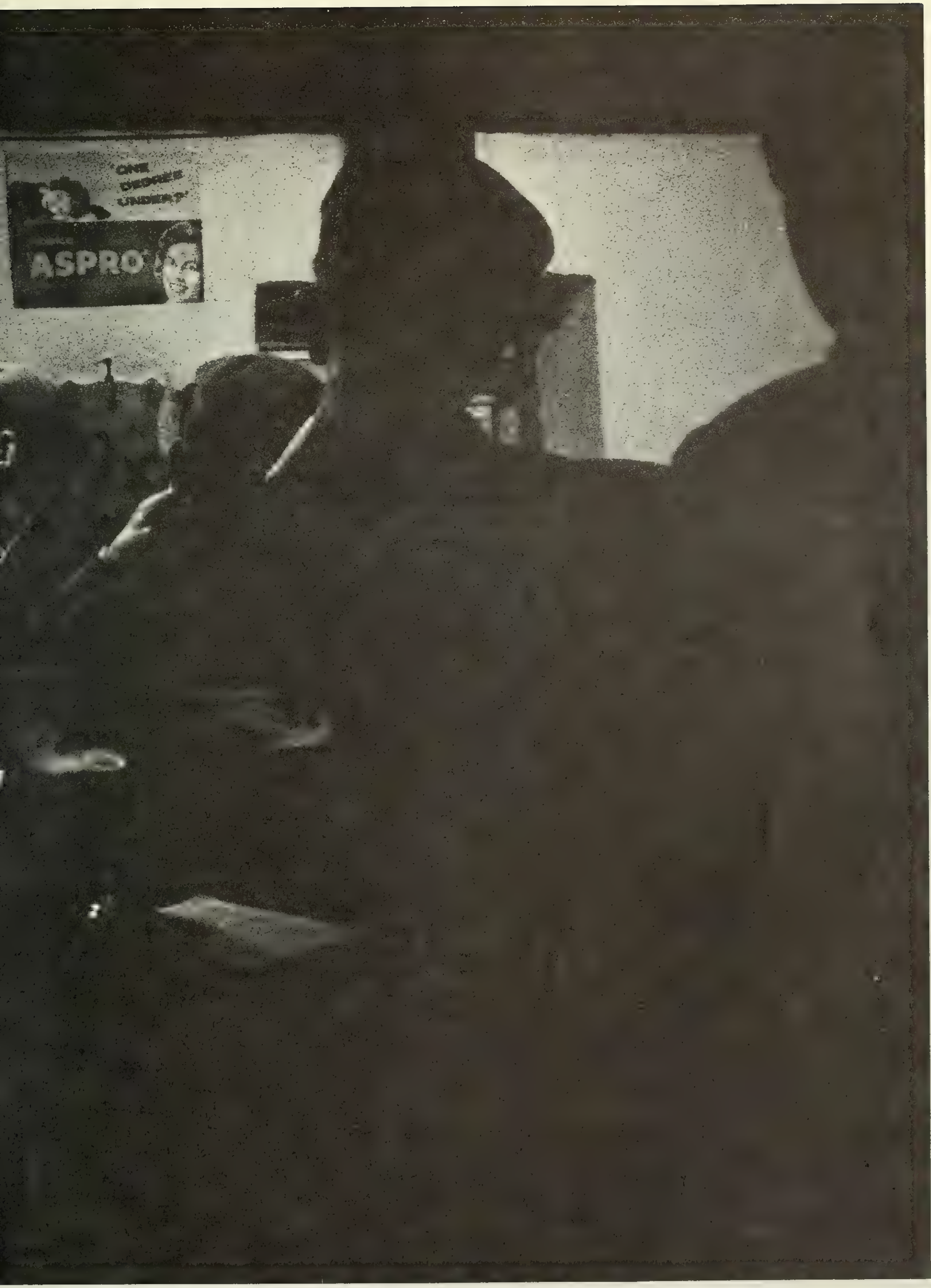
A dramatization of "Chicken Little" in Gaelic.

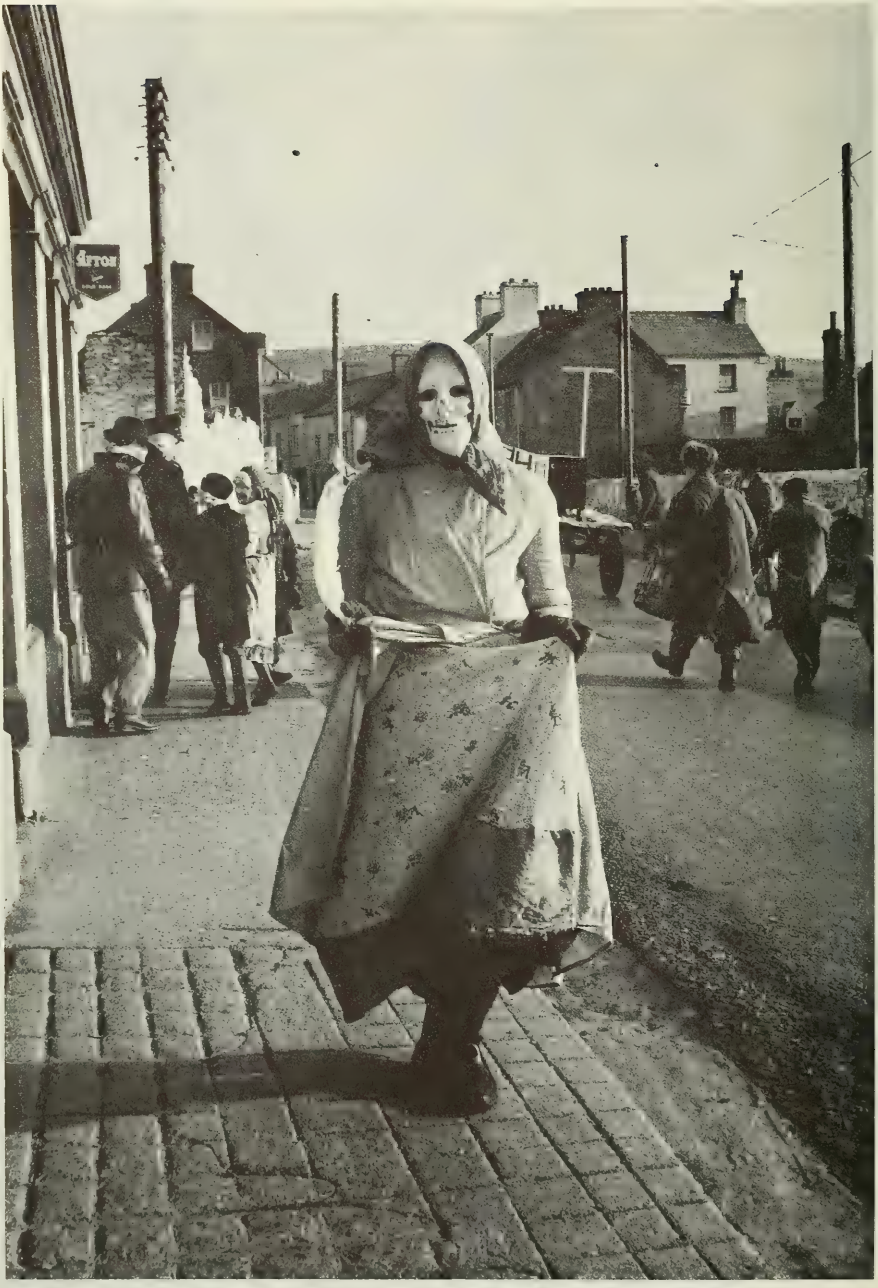


THE NATIONAL BANK LTD

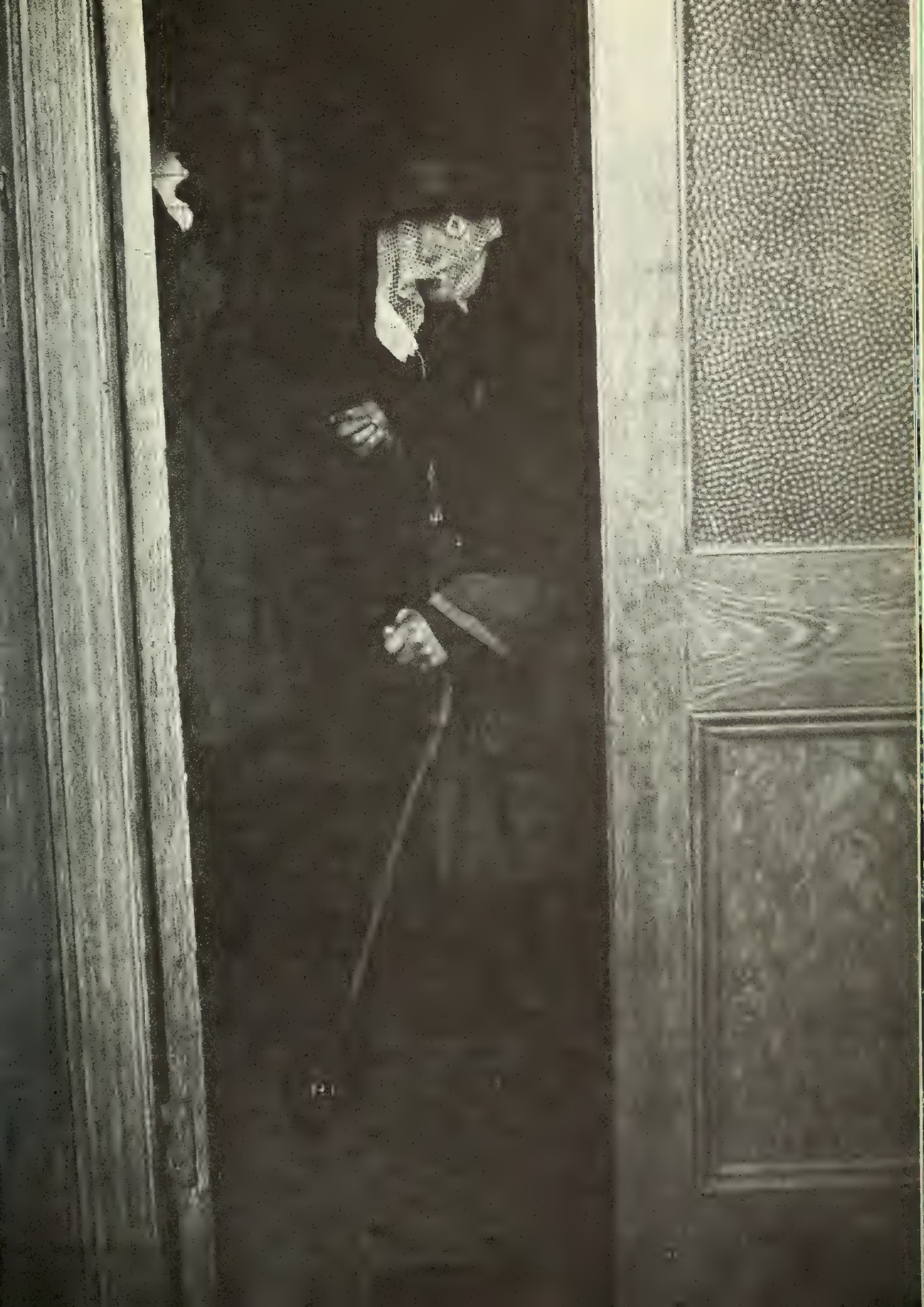


DRI FAB

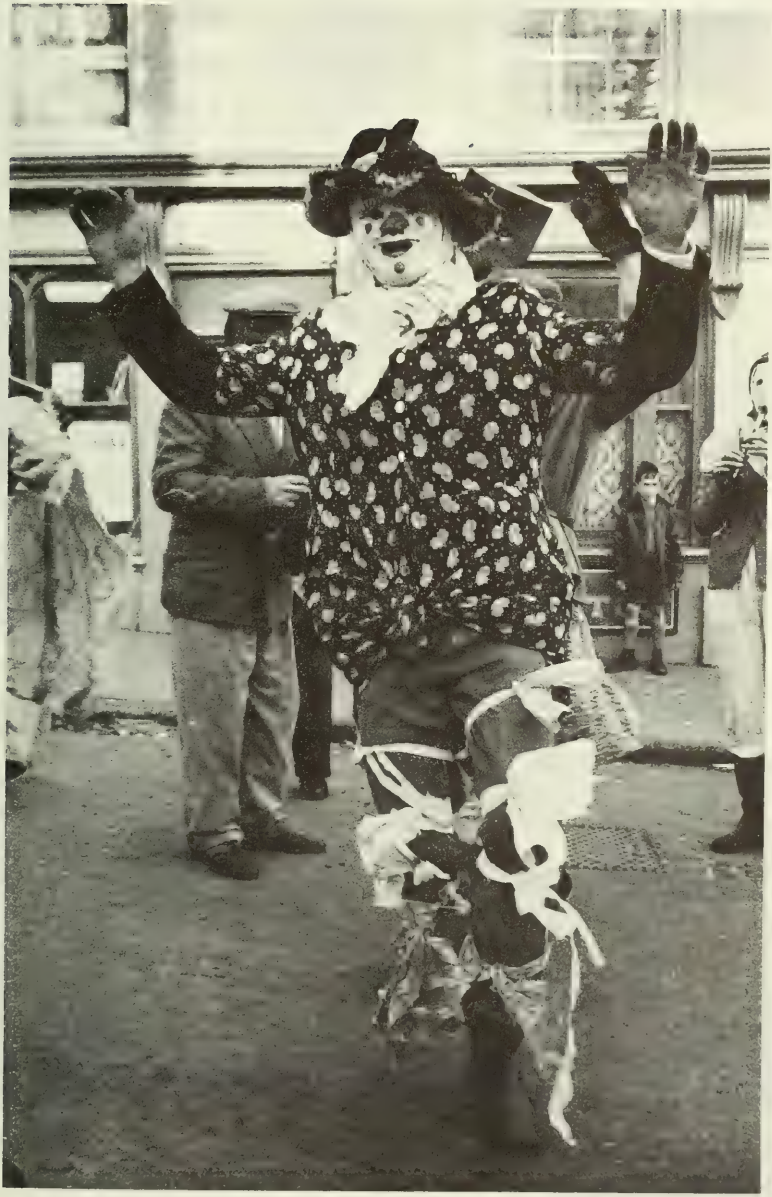

ONE DEGREE UNDER?
ASPRO



On the Day of the Wren, December 26, masked revelers trek through the streets to Dingle.



Paolo Soprani



"The country was full to the lid of songs and stories, and you would not put a stir out of you from getting up in the morning to lying down at night but you would meet a poet, man or woman, making songs on all that would be happening.

It is not now as it was then, but it is like a sea on ebb, and only pools here and there left among the rocks."

Thomas O' Crithin

The Supercivilized Weather and Sky Show

brought to you by the producers of Contrails, Dust, and CO_2

by Henry Lansford

"Rain follows the plow." During the last part of the nineteenth century, when the Great Plains of the United States were opened up to homesteaders, that catchphrase was the sodbuster's central article of faith and the shibboleth of the prophets of manifest destiny. It neatly expressed the widely held belief that breaking ground for agriculture would produce a prompt and substantial increase in precipitation on the semiarid high plains, which Maj. S. H. Long had called the "Great American Desert."

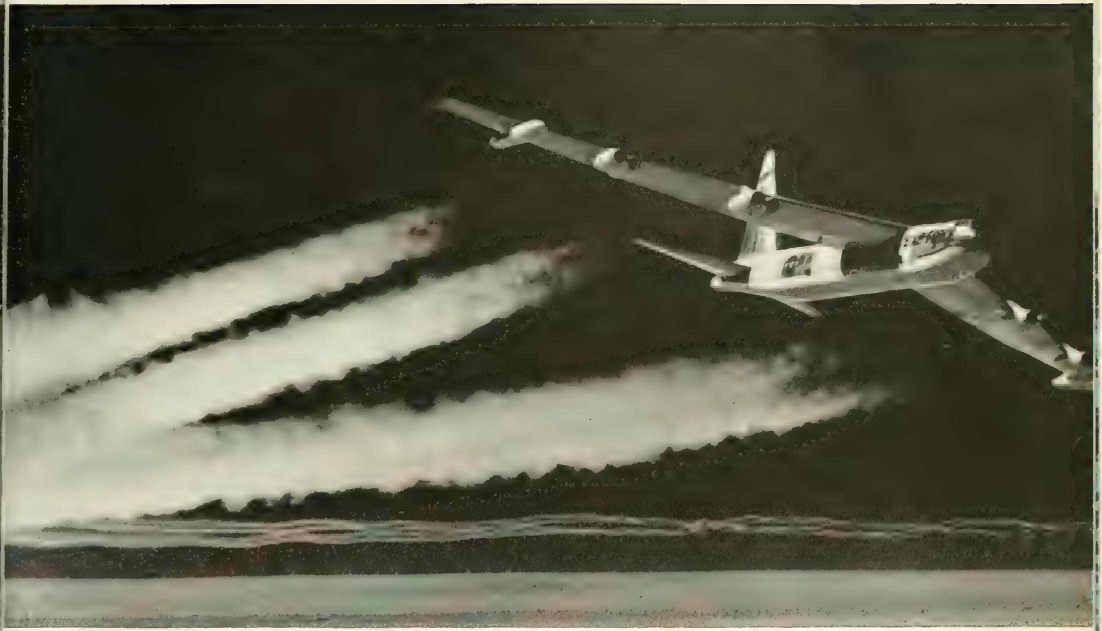
The idea was generally accepted both by promoters and by homesteaders for whom it filled a deep emotional need. But believers also included many scientists and public officials who should have been more skeptical. For this belief was based on a combination of wishful thinking and bad logic: Homesteaders had plowed and planted the land, followed by several years of decent rainfall, more than had been noted previously. Therefore, rain must follow the plow.

The logic was refuted soon enough by half a century of alternating dry and not-so-dry spells, marching along in a heartbreaking cycle that could dry up a farm and blow it away just when the homesteader had decided, on the strength of three or four good years, that he was going to succeed. The Dust Bowl years of the 1930's underlined the inescapable conclusion that the climate had been swinging through natural variations unaffected by man's scrabbling at the face of the earth.

The settlers of the Great Plains were neither the first nor the last men to jump to unwarranted conclusions about man's effects on weather and climate. The ancients believed that great battles brought deluges sent by the gods to wash away the blood and gore. And in our time, during a long East Coast rainy spell that followed the Apollo 11 moon landing, television weathermen received many telephone calls from people who were certain that Neil Armstrong and Buzz Aldrin had somehow put an end to clear days and sunny skies.

But can skepticism go too far? Although the above notions have no apparent scientific basis, many atmospheric scientists are now convinced that man is indeed changing weather and climate, perhaps on a large scale, and doing so quite unintentionally. The changes are side effects from various human activities. Some of these scientists can support their hypotheses with detailed documentation. Others admit that they are speculating, but their scientific credentials, and the potential consequences of events they suspect are taking place, present a powerful argument for promptly and thoroughly investigating the effects of human activities on the atmospheric environment.

Most weather phenomena involve tremendous amounts of energy. The source of this energy is our nearest star, the sun. Each week, our planet receives more energy from the sun than that contained in all the coal, oil, and gas that man has ever burned and in all the known reserves of these fossil fuels on earth. Much of this short-wave solar



energy passes through the atmosphere, is absorbed by the land and the oceans, and is radiated back into the atmosphere as long-wave heat energy, which provides the driving force for the large-scale motions of the atmosphere. Even a brief, local thunderstorm involves energy that probably equals the amount released by several hydrogen-bomb explosions.

How, then, can the side effects of man's puny enterprises influence systems of such enormous energy? The answer may be expressed in an elementary analogy. How can a man stop a charging rhinoceros by twitching his right index finger? Triggering mechanisms, by which a small input sets off a large result, can determine the behavior of weather systems just as a squeeze of the trigger finger can send out a high-powered bullet and stop a rhinoceros.

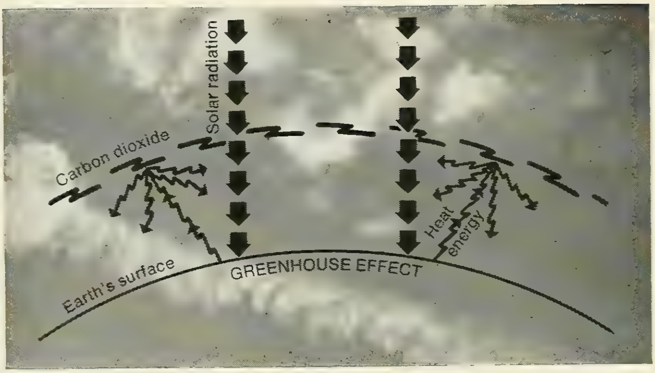
I can see one highly visible example of an atmospheric triggering mechanism by looking out of my window at the National Center for Atmospheric Research in Boulder, Colorado. High-flying jet airliners traverse the skies over this area almost constantly. Often, on a bright morning in fall or winter, I look out my window to see white trails beginning to cross the sky. These are contrails—condensation trails—triggered by jet aircraft. The general public began seeing these when high-flying jet bombers, such as the B-52, came into use. The advent of jet airliners has made them an increasingly common sight over much of the world. Produced by the combination of heat, moisture, and particulate matter in the jet-engine exhaust, they are simply highly localized artificial clouds.

At first, the contrails over Boulder are like clean chalk lines on a blackboard. Sometimes they vanish immediately. But if conditions are just right, they start to blur and spread: by midafternoon they often merge into a thin layer of cirrus—wispy, high-altitude clouds composed of tiny ice crystals. Some meteorologists call them "false cirrus" to distinguish them from cirrus formed without the benefit of jet aircraft. But they are identical in every other respect to "natural" cirrus clouds.

Is this inadvertent triggering important in the development of weather patterns? Will it become more significant as jet aircraft become bigger and more numerous?

Dr. Walter Orr Roberts, president of the University Corporation for Atmospheric Research, has been watching contrails for many years and speculating about their influence on weather. He says that we simply lack enough data to predict the consequences of present trends in air-transport technology, and adds that it's rather late to start such studies after the new technology has arrived and begun affecting the environment.

First, Roberts feels we should find a solid, quantitative answer to the question of whether man's intervention via jet aircraft operation is actually adding to the cirrus cover. If the jets are creating cirrus that would not have formed naturally, how does this affect weather, and what will happen when the era



Increasing amounts of carbon dioxide tend to heat the earth. Sunlight reaches the surface, but the resulting heat energy cannot escape back into space.

of the supersonic transports (SST's) becomes a reality? Again, we lack hard data. but some scientists, deeply concerned with the urgency of the problem, are willing to hazard informed guesses.

Dr. Reid Bryson, head of the Institute for Environmental Studies at the University of Wisconsin, has speculated that we may see a striking result as soon as there are several hundred supersonic jet transports in the air at the same time. They might well produce 100 percent cirrus cover over those regions where most of them will operate. Bryson believes that such cloud cover would definitely cause climatic changes and is dismayed by other implications of his prognosis: "We would like our grandchildren to experience blue skies more often than on rare occasions." Other climatologists qualify their pessimism. One viewpoint, for example, is that of all the different types of clouds. cirrus have the least influence on our planet's heat balance; only when they become uncommonly dense, or when they form at unnaturally high altitudes, are they likely to play an important part in weather processes.

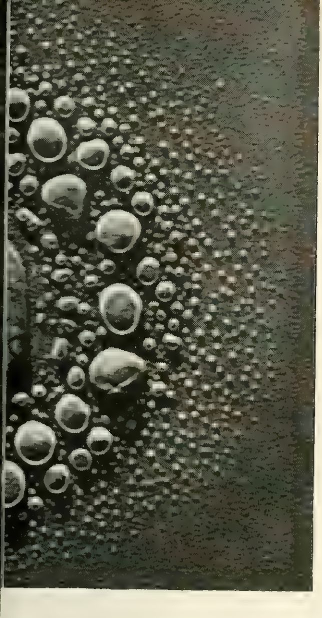
Dr. Roberts adds that the cirrus cover could have significant effects if it occurs in the right place at the right time. If it is winter, persistent and general cirrus cover over a high-latitude region where the surface temperature is comparatively warm, perhaps the Gulf of Alaska, might have an important effect on the global circulation. This would result from holding back heat energy that otherwise would escape from the atmosphere into space.

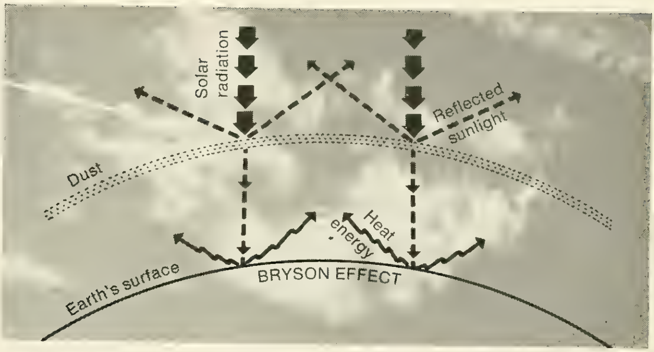
At first glance it is tempting to choose the simplest, cheapest way of finding the answers, namely, to wait and see what happens to the balance of forces in the atmosphere when we have several hundred SST's flying around in the atmosphere. But once you've pulled the trigger, it's too late to change your mind about killing the rhinoceros. And once the general circulation patterns of the atmosphere have been altered, it may be too late to reverse the processes that are causing the new kinds of weather.

Another scientist concerned with possible weather changes caused by human technology is Dr. Vincent J. Schaefer. who heads the Atmospheric Science Research Center at the State University of New York. In 1946 he performed the first successful cloud-seeding experiment (*see* "When Will We Change the Weather?" NATURAL HISTORY. December, 1967). Since then, Schaefer has tested many cloud-seeding techniques. But he is beginning to suspect that he may have done more cloud seeding inadvertently—with his automobile—than he has done deliberately in all his years of research.

Cloud seeding is based on the existence of atmospheric water in the form of supercooled clouds that are made up of tiny, still liquid water droplets, although they are colder than 32° F., the nominal freezing point of water. If conditions are right, and ice crystals do form in such a cloud, they grow rapidly, taking up moisture from the droplets around them. And if enough moisture is available, the crystals soon grow into snowflakes large enough to fall from the cloud. On a cold day they reach the ground as snow; when it is warm, they melt and fall as rain.

Cloud seeding is a technique for stimulating the formation of the first tiny ice crystals in a supercooled cloud. Tiny airborne particles—so-called freezing nuclei—serve as centers around which the crystals form and grow. In the absence of sufficient natural nuclei, a cloud may be seeded artificially by introducing crystals of dry ice, silver iodide. or some other effective substitute. The principle of most at-





On the other hand, more dust in the air may cool the earth by reflecting sunlight away before it can reach the surface. At left is a droplet of sulfuric acid — spewed into the atmosphere by both natural and man-made processes — which may also reflect significant amounts of sunlight.

tempts at deliberate weather modification is that if the right amount of seeding material is placed in a cloud under the right conditions, precipitation can be stimulated and rain or snowfall can be increased.

Lead iodide has proved to be an effective seeding material; a small quantity of lead iodide can have a large effect on a supercooled cloud. Although lead iodide itself is not naturally present in the atmosphere, iodine is nearly always there. It enters the air from sea spray, wood smoke, and other natural sources. Thus the "trigger" is cocked; to "pull it" requires only a source of lead to combine with the iodine. Lead is one of the additives in the fuel we burn in automobile engines. Daily, in every large city, a flood of leaded gasoline is poured into the tanks of hundreds of thousands of automobiles. The exhaust gases from the automobiles, heavy in lead compounds, are a major ingredient of the air pollution that spreads through the atmosphere around metropolitan areas.

Does the lead in this urban effluent combine with the iodine in the atmosphere to produce a compound that can effectively seed supercooled clouds? Schaefer believes that it does. He introduced iodine vapor and automobile exhaust gases into a laboratory cold chamber, at various subfreezing temperatures, and got high concentrations of freezing nuclei. He followed this experiment by combining the exhaust gases with natural sources of iodine. "I have now discovered," he reports, "that if I burn thin wood chips in my cold chamber and then add to the air a sample of auto exhaust, I again find high concentrations of ice crystals."

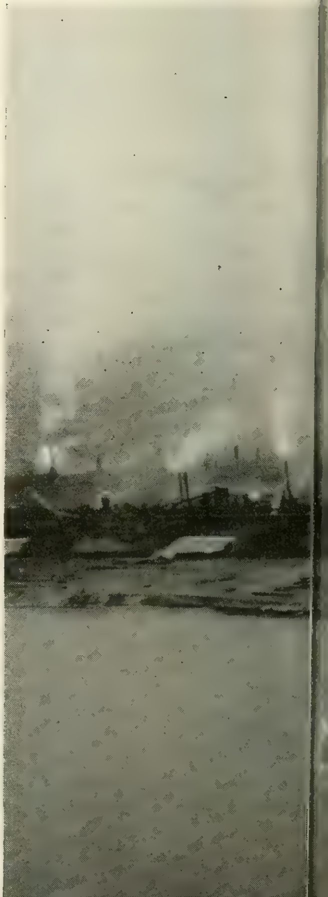
He performed these laboratory tests to try to account for some unusual atmospheric phenomena that he has observed in recent years when flying near large cities. These phenomena include a number of snow and rain storms in the east-central part of New York State. They produced snow that was almost like a fine dust, and rain that drifted down in tiny droplets. The surmise is that these storms were overseeded by pollutants; that with an overabundance of nuclei the available moisture produced a tremendous number of tiny particles, leaving insufficient moisture to make them grow larger. Schaefer has also noted another apparent result of unnatural seeding—extensive plumes of ice crystals above and downwind from large cities such as New York, Chicago, Detroit, and Buffalo. In sum, his experiments support his theory that the atmosphere in the vicinity of large cities is being inadvertently seeded by air pollutants.

This process could have a variety of effects on the weather. It could suppress normal precipitation by turning all of a cloud's moisture into ice crystals too small to fall. Furthermore, if an urban-produced plume of ice crystals encounters a large mass of moist air the sudden sublimation of large amounts of water vapor onto the ice crystals could release great quantities of latent heat, triggering a massive storm. And we have already seen that a cover of false cirrus might alter the development of weather systems. Like many fellow scientists, Schaefer admits that he cannot explain precisely what is happening, but he suspects that the effects of unintentional seeding may be widespread and serious: "In a subtle manner it seems to be changing the nature of clouds over increasingly large areas of the globe." He goes on to warn that if pollution leads to increased dustiness from ill-used land, to more cloud nuclei from burning trash, and to many more ice nuclei from leaded gasoline, not only will we lose the possible advantage we now have of extracting some additional water from our "sky rivers," but we might even be confronted with a drastic change in our climatological patterns.

It was such a change, on a local, rather than on a global scale, that led Stanley A. Changnon, Jr., of the Illinois State Water Survey, to investigate and document one of the most striking examples of inadvertent weather modification that has yet been detected. Concerning this phenomenon, which he calls the La Porte weather anomaly, Changnon reported: "A notable increase in precipitation, moderate-rain days, thunderstorm days, and hail days has been occurring since 1925 at La Porte, Indiana. Because La Porte is 30 miles east of the large complex of heavy industries at Chicago, there is a strong suggestion that the increases are due to inadvertent man-made modification."

Changnon's case for the reality of the La Porte weather anomaly, though circumstantial, is highly convincing. Long-term weather records from La Porte show that precipitation there increased between 30 and 40 percent over a period of 40 years. This increase parallels the upward curve of iron and steel production in the industrial complex at nearby Chicago and Gary, Indiana. The precipitation curve follows the fluctuation of the industrial production curve faithfully, swinging up in the early 1940's when World War II caused a sudden increase in steel production. Analysis of the records for 1965 shows that La Porte had 31 percent more total precipitation, 38 percent more thunderstorms, and 246 percent more hail days during that period than nearby weather stations in Illinois, Indiana, and Michigan. Furthermore, La Porte's days of bad weather correlated closely with days when Chicago's air pollution was bad. Hence the belief that La Porte's long run of bad weather can be attributed to the great quantities of heat, moisture, and pollutants belched into the atmosphere by Chicago's industry. The heat and moisture, particularly during cool hours of night and early morning, stimulated the formation of cumulus clouds. Carried out across the tip of Lake Michigan by prevailing westerly winds, the growing clouds picked up more moisture. By the time they reached the La Porte area, they

A jet contrail slowly diffuses into a cirrus cloud, below. Pollution such as that along Lake Erie, at right, may overseed storms downwind, producing very fine rain or snow.



were thunderheads ready to be seeded by nuclei in the pollutants that were also drifting east from Chicago.

Climatological records have also led to other theories about the possible effects of human activities on average worldwide temperature. As with Changnon's analysis, these are after-the-fact attempts to account for changes shown by long-term records. However, the La Porte records concerned striking changes in a local area, with a correlation between hypothetical cause and actual effect that could be established rather conclusively. The theories about global temperature changes, while they are based on facts, are much more speculative. Long-term records clearly indicate a gradual but steady global warming trend from about 1880 until 1940. This warming was not the sort that would substantiate the old-timer's claim that winters aren't as hard as they were when he was a boy. It amounted to less than one degree of increase in the world mean temperature over a 60-year period. But it was real enough.

Some scientists have tried to account for the trend by citing the "greenhouse effect." Like the glass roof of a greenhouse, atmospheric carbon dioxide admits short-wave radiation from the sun but blocks the escape from earth of long-wave heat energy. Carbon dioxide is produced when coal and oil are burned; and the warming trend coincided with the period when industrial growth was occurring over much of the world. Hence the explanation that man's industry must have caused the trend. And, added the Cassandras, this warming would eventually melt the polar ice caps, thereby raising the level of the oceans and drowning New York, London, and other coastal cities. This theory has a fine apocalyptic ring, and has gotten a good bit of attention over the years in the Sunday supplements. But as far as logic is concerned, this is simply a case of "rain follows the plow" writ large. Nobody knows enough about the actual carbon dioxide levels, or understands the role of carbon dioxide in the radiation budget with sufficient precision, to say for certain that industry's carbon dioxide caused the warming.

Then, about 1940, the trend began to reverse itself. Gradually, the annual mean temperature started

Continued on page 112

MIGRATION OF THE BARREN-GROUND CARIBOU

by John P. Kelsall

My introduction to the barren-ground caribou, nearly two decades ago, was an unforgettable event. With an equally inexperienced companion I camped on the Arctic coast at Bathurst Inlet, about a mile and a half north of the Arctic Circle. In order to study calving (not previously seen by scientists) and calves, we planned to intercept caribou migrating northward.

On May 25, 1950, two days after we had set up our base of operations, a major caribou migration across ten to twelve miles of sea ice began from the far side of Bathurst Inlet. During the next three days, more than thirty thousand animals crossed the ice. The feeding animals covered the surrounding hills; sometimes they literally stumbled over our tent ropes. We lay motionless on the open ground and found that even downwind of us caribou would pass within ten to fifteen feet. Their movement was accompanied by a steady clicking sound, like that of castanets, produced by the hooves with each step. Occasionally, the thousands of caribou on the ice all advanced purposefully toward us in long, parallel files of 10 to 150 animals each, spreading out only when they rested or fed.

Before the first movement of caribou was over, a second herd approached the inlet from the opposite direction, apparently to drop their calves among the big hills just vacated by the first herd. We were treated to the sight of two major herds of caribou migrating through each other. Literally thousands of animals, some files going east, some west, countermarched across the ice within yards of, but seemingly oblivious to, each other.

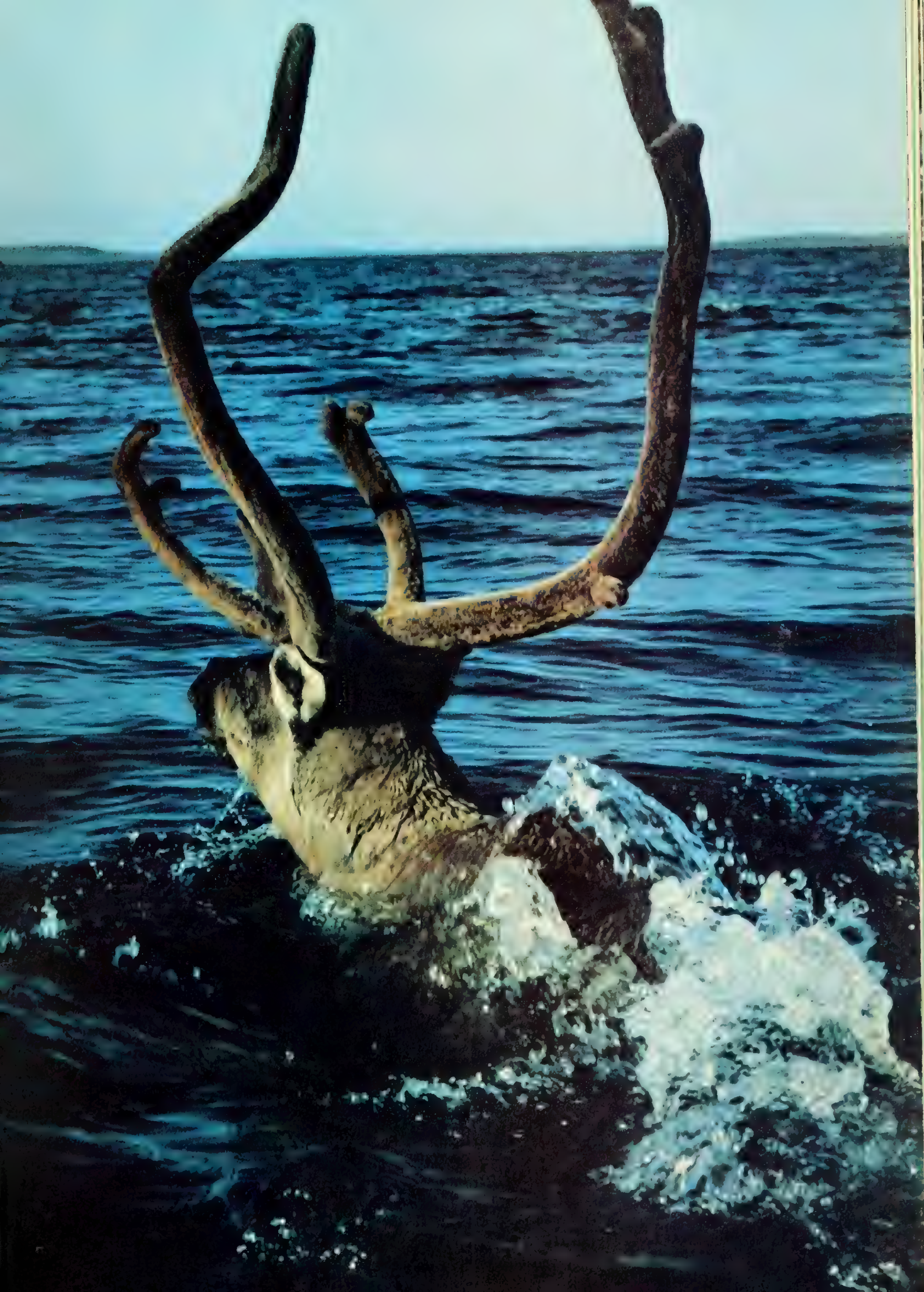
The caribou migration generated all sorts of activity by other animals. Eskimo hunters, after a long winter of eating seals, came to shoot caribou for meat, both to eat fresh and to dry for later use. Wolves, denning nearby, frequently visited their kills and carried meat back to their pups. Scavengers, too, were active. Ravens and glaucous gulls were common and noisy. A pomarine jaeger and five gulls waited for more than an hour to feast on the remains of a freshly killed caribou being sampled by a wolf. A den of red foxes lived well by scavenging.

Small, ground-nesting birds, on the other hand, did not fare well. Nests of Lapland longspurs, horned larks, and golden plovers were trampled by the hooves of passing caribou. Larger nesting birds—willow and rock ptarmigan, parasitic jaegers, and some of the waterfowl—defended their nests by a form of brinkmanship. They would sit tight until they were about to be stepped on, then suddenly flush, causing the startled caribou to shy away. Whistling swans simply drove the animals away.

We discovered a phenomenon common to most arctic researchers in spring and summer—sleeplessness. Twenty-four hours of daylight, combined with a tundra alive with animals, fresh growth, and blossoming plants, made us begrudge the time necessary for sleep. We shared the spirit of the Eskimo children. Full of the joys of spring, they simply ran until they dropped, slept for a while, and refreshed, got up to run again.

On the Canadian mainland barren-ground caribou (*Rangifer tarandus groenlandicus*) have a continuous range of over 700,000 square miles, made up almost equally of tundra—the so-called barren grounds—and boreal, or northern, forest. This enormous land area has generally low relief with elevations rarely exceeding 2,000 feet. The gently undulating landscape is marked by the past activity of glaciers—residual drumlins and eskers—as well as striations and gouges on exposed rock surfaces. Myriad lakes range from tiny ponds to freshwater bodies among the largest in the world. Great Bear Lake, for example, covers 12,000 square miles and is considerably larger than either Lake Ontario or Lake Erie. In some localities, lakes

Miles of icy lake present
obstacle to the caribou,
excellent swimmer. Its Canadi
range is one-third wat



are so numerous, they cover up to 60 percent of the land area. This accumulation of water is almost entirely due to short, cool summers—which inhibit massive evaporation—and to the permanently frozen subsoil, or permafrost, just a few inches below ground level—which inhibits drainage.

The presence of so much water is curious because over most of the caribou range the total annual precipitation, both rain and snow, is within limits usually associated with deserts. The forested parts of the range receive an annual precipitation of ten to thirteen inches, of which about half is winter snowfall. Northward on the tundra, precipitation varies from ten inches to six inches or less, and again, about half of it is in the form of snow. Even during winter caribou ranges are not snowbound; they generally have a snow cover of less than twenty inches at any given time.

Temperatures in the north are not so extreme as many people think. I have experienced 85° F. at the Arctic Circle in summer but, over most of the mainland tundra, mean maximum temperatures are about 5° lower. Mean minimum temperatures of —50° F. are remarkably similar throughout the barren-ground caribou ranges. That undoubtedly seems very cold to those who have never experienced a Canadian winter. but it is not much colder than temperatures tolerated by hundreds of thousands of Canadians in major metropolitan areas farther south.

No thumbnail sketch of caribou ranges is complete without mention of the vegetation. The coniferous forests of the winter ranges are dominated by white and black spruce or by jackpine, depending on the location. In the forest, car-

Massed together during July's plague of biting insects, harassed herds run furiously and erratically about the tundra.

Castanet-like clicks – thought to come from foot tissue movements – break the snowy silence as an Alaskan herd heads north.

ibou primarily eat lichens—the so-called caribou moss. Using their forehooves to dig beneath the snow, they unearth *Cladonia*, *Cetraria*, *Peltigera*, and *Stereocaulon*—among the most important lichens to caribou in north-central Canada. The winter diet also includes a variety of sedges, shrub leaves and twigs, and arboreal lichens. Because the slow-growing lichens preferred by caribou are most plentiful in climax coniferous forests, forest fires are extremely damaging to caribou winter ranges. Studies in Canada show that lichens may take more than 100 years to recover from fire and to regain their usefulness to the animals.

In spring, summer, and early autumn, caribou are much less choosy about what they eat. Now they are on the tundra, where their main foods are green-growing plants of all sorts, particularly the new shoots of sedges, many species of low-growing tundra willows, and glandular birch, as well as large quantities of lichens. And they like variety. I have watched caribou in the spring select the carrotlike roots of lousewort. Using their lips, they worry around a plant, exposing the root so that it can be grasped firmly and pulled up.

Except in particularly arid or rocky sites, there is no shortage of food on the tundra. In this respect, the commonly used term "barren-grounds" is a misnomer. Ernest Thompson Seton called the tundra range of the barren-ground caribou by the more appropriate term "arctic prairies." Although vegetation generally grows low, in most places it covers at least 70 percent of the ground. In early summer, I have competed with caribou and ground squirrels for abundant mushrooms and other edible fungi. Later in the season, I have displaced ptarmigan, geese, and other birds as well as mammals in a search for cloudberries, bilberries, and mountain cranberries. But on occasion I have been displaced by the rarest great mammal of the tundra—the barren-ground grizzly.

The barren-ground caribou's gregariousness and migratory habits are the chief factors that complicate its study and management. Range maps, of the sort on page 104, can give only a general picture of caribou distribution. The southern boundary of "extreme winter range" shows the caribou's greatest-known penetration of forests since 1935, and no point along it has been reached more than twice during that period. In winter most caribou occupy the area of "usual winter range," but specific points within that area are generally visited by the animals no more often than every other winter and, frequently, not even that.

Occasionally in spring and early summer the animals become almost unbelievably concentrated. I once watched northward-bound caribou that were temporarily blocked at the confluence of the Dubawnt and Thelon rivers by swift waters full of broken ice. For several days the animals jammed the shore of the river waiting for the water to clear; so many and so dense were they that accurate counts were impossible. However, experienced observers made aerial estimates of 80,000 to 100,000 animals. At least one-third of the entire caribou population had gathered in an area of about 250 square miles.

At most times of the year barren-ground caribou cluster together in groups. Pregnant females enjoy a brief solitude during calving, but only within the restricted area of their calving grounds. Otherwise August is the only season in which the animals scatter widely. Then, the first frosts eliminate or greatly reduce the blackflies and mosquitoes, which for the previous five weeks harassed the herds almost to the point of desperation and caused the animals to lose as much as 20 percent of their body weight. No longer plagued by these pests, the caribou turn to the individual pursuits of resting, eating, and regaining their strength and weight, as they drift southward toward the treeline. Once there, about the end of August, they move haphazardly and unpredictably for a month or more. They travel back and forth along the treeline, sometimes penetrating the forests for considerable distances before returning to the tundra, where they coalesce once more into aggregations that grow larger and larger as the season advances. The rutting period in late October and early November still finds most of the caribou wandering at the treeline.

The first heavy snowfall seems to trigger migration toward the forested winter ranges, even though the rut may be in progress. The caribou are usually in full migration in November, arriving at their winter quarters in early December.

There, the animals are concentrated and movement is leisurely. They tend to move down snow gradients, from those areas where snow is deep, hard, and dense to where it is shallow, soft, and fluffy. Here, travel and digging for food is easy. While most barren-ground caribou take to the forested ranges in winter, there are exceptions, and in some years of light snow, up to half the population has remained on the tundra.

Starting in late March, spring migration draws caribou from their winter ranges to calving areas far out on the tundra. During this migration, the pregnant cows travel swiftly and purposefully, hindered

Caribou on the move form long, parallel files, spreading out to rest or feed. Migrations often exceed five hundred miles.

only by impassable topographical obstacles or violent weather. After covering vast distances, often more than five hundred miles, the animals arrive on the calving grounds by late May and drop their calves among the melting snowdrifts in early June.

Bulls and nonbreeding cows often lag behind but may catch up with the cows during the calving period. When they do, they congregate on lush river valleys and coastal plains, while the cows drop their calves nearby on the high, barren, and bleak country. However, when the migration routes are long and lake and river ice breaks up early, the laggards may become isolated from the cows and calves and rejoin them only in late summer. Cows and newborn calves descend to lower, better pastures, sometimes joining the bulls in the first week of July.

Routes, ranges, and times of migration vary from year to year, but there is an annual pattern basic to all movements of barren-ground caribou. Their travels take them in a specific direction. In spring, migration is decidedly goal-oriented, moving from the winter range to the nearest calving area. As can be seen on the map, the eastern caribou migrate along an approximate north–south axis, but the western caribou's migration tends toward an east–west axis—the shortest distance between winter and summer ranges.

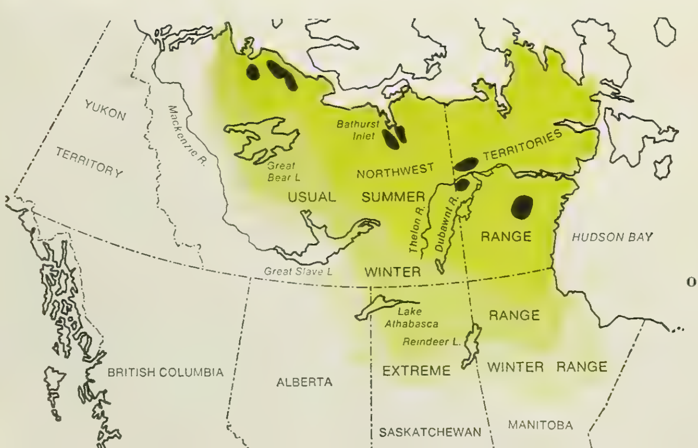
Added to basic annual movements are population shifts that cause a complex and changing picture of caribou distribution when viewed over several years. Such unusual movements occur during nonmigratory periods in the winter, or after calving in the summer. At these times, the animals may wander far to one side of the lines followed during their previous migration. When the next migratory period arrives they simply head for the nearest winter range or calving area, depending on the season. In a single season, caribou may shift laterally several hundred miles across normal migration lines. Movements that cover vast distances and that cross established migration routes are unpredictable and, as yet, inexplicable.

Since the seventeenth century caribou have been literally the staff of life for many of the explorers, traders, missionaries, and other travelers of the Canadian north and, of course, to the native people before them. The success, or failure, of many human enterprises has depended absolutely on whether caribou could be secured for food and other needs. While travelers and traders no longer rely on it, many scattered residents still do. Within the past two decades Canadian Eskimos have starved to death because they could not obtain caribou and had no alternative food resource.

The fur trade opened Canada's northland and, until recently, was its only major commercial enterprise. It flourished for more than two hundred years and expanded to all parts of the northern caribou range, where the trading posts were the only permanent centers of European civilization. The ubiquitous caribou, supplemented by fish, provided food for the steadily increasing numbers of traders and trappers. Today, most trading posts are supported entirely by commercial food products, but this has been the case at many of them for no more than twenty or thirty years, and a few outposts and small Christian missions still depend on caribou and fish for much of their protein.

Canadian Indians and Eskimos traditionally took few more animals than were needed for food, clothing, and tents. It has been estimated that those totally dependent on caribou required about forty animals per adult per year; those with other food sources, such as marine mammals or moose, needed fewer.

Before expansion of the fur trade, Indians and Eskimos kept a few dogs as an occasional convenience. The fur trade, however, made large and powerful dog teams necessary to transport gear and furs around extensive traplines and to maintain an enormous communication network between northern settlements in winter. The nomadic natives could not permanently support more than a few dogs, but the introduction of a trapping economy, and firearms to secure game at any time, made it essential and possible to keep large dog teams. In recent years, most Eskimo hunters have had teams of six to ten (or more) dogs; and most Indians,



Caribou drop their calve
in melting snow drifts far ou
on the tundra. Black areas on ma
left, indicate calving ground

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four to seven. On that basis, the average native family was feeding more dogs than humans. Even though it weighs less than half as much, a sled dog needs about half the protein ration of a human. Therefore, it is likely that dogs have eaten at least half of the caribou taken in the north. In the last decade, motorized toboggans have made the sled and its voracious dog team obsolete, and fortunately for caribou, dog populations in the north have been greatly reduced.

More than two hundred years of exploitation resulted in a period of crisis for caribou shortly after the Second World War. The ranges of tundra and boreal forest probably supported over two million animals in early times. The first range-wide survey, in 1948–49, estimated 668,000 caribou. A second survey in 1955 estimated 272,000. That catastrophic decline, often referred to as Canada's caribou crisis, stimulated much research and management, including my nine-year employment as a caribou biologist. Implementation of sound conservation measures; unusually high survival of calves for several years; and the entry of native hunters into the wage economy when caribou became too hard to get, all resulted in a population increase—to nearly 400.000 in 1967.

However, the barren-ground caribou's future is neither safe nor particularly hopeful. Recent legislation by the government of the Northwest Territories permits any person with a year's residence to shoot five barren-ground caribou—of any sex or age—annually and in any season. More disturbing, Indians and Eskimos, who were always permitted to take all the caribou they could use for their own consumption, are now allowed to sell the meat, within generous limits, to anyone, including restaurants, mining camps, and hotels. Previously, market hunting of game had not been legal for many decades in Canada.

The Canadian prairie provinces share the migratory caribou with the Northwest Territories. Should public pressure force a relaxation of hunting regulations in these provinces to conform to those of the Territories, the results could be disastrous for the animals.

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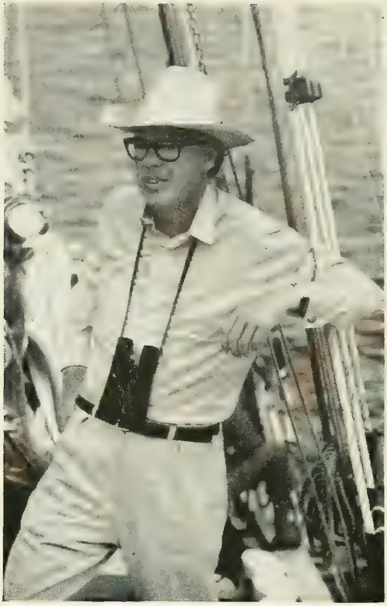

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Sky Reporter

The Moons of Mars So tiny they might properly be called moonlets, the two Lilliputian moons of Mars have been pretty much ignored while astronomers concentrated on bigger game. They have been literary curiosities of a sort, because their existence was predicted by both Jonathan Swift and François Voltaire a century before their discovery by Asaph Hall in 1877. More recently they enjoyed a brief notoriety when the Russian astronomer I. S. Shklovski proposed that they might be spherical artificial habitats launched into Martian orbit when that planet was no longer able to support life.

The truth appears to be, as many suspected right along, that the two moons, Phobos (Dread) and Deimos (Terror), are probably small, irregular chunks of asteroids, captured when they swung too close to Mars. Even from the surface of Mars, Deimos would be no brighter than Venus seen from the earth. Phobos would be more interesting: it would appear to have about a third of the apparent diameter of our moon as seen from earth. Phobos is so close, just 3,700 miles above the Martian surface, that it could not be seen from high latitudes. It revolves around its parent in just 7 hours and 39 minutes, less than a third of the Martian day. This means that Phobos would appear to rise in the west and set in the east, going through more than half its phases in its 4½-hour passage through the sky.

As Mariner 7 approached Mars last summer, pictures taken at a distance of 81,000 miles show Phobos in silhouette against a relatively bright portion of the planet just west of the prominent dark area Syrtis Major. The image is fuzzy and featureless, but does reveal two important characteristics: the moonlet is elongated along its orbital plane, and it is darker than any other known body in the solar system.

Phobos is fourteen miles across the orbital plane and eleven miles up and down, slightly larger than previously thought. Bradford A. Smith of New Mexico State University, reporting his findings in *Science*, suggests the asymmetrical shape means that Phobos did not form by accretion as it orbited within the planetesimal cloud around primordial Mars, but was captured in its present form at some later time.

The moonlet's surface is so dark, he suggests, because meteoric bombardment may knock off any dust that would accumulate. Incoming meteors travel fast under the pull of Martian gravitation, while the gravitation of Phobos is so weak and its escape velocity so small that any loose particles are knocked free (a man standing on Phobos would weigh only an ounce or two; he could easily jump several miles).

No images of Deimos have been identified from the Mariner pictures. It is even smaller, only five or six miles across, and also presumably a captured asteroid.

Mapping Mercury Continent-sized "rough spots" on the planet Mercury are being mapped with radar by astronomers at the Goldstone Tracking Station in California. The topographic features, similar to those detected earlier on Venus, could be mountains, boulder fields, craters, or any rough surface.

Mercury is difficult to study optically because it is never very far from the sun in the sky. It also presents a difficult radar target because of its distance from the earth and its small size. But three times a year, when Mercury comes closest to the earth, a Goldstone team headed by Richard M. Goldstein aims a 450-kilowatt beam at the innermost planet. It takes each pulse ten minutes to travel to Mercury and return to earth.

More difficult are analyses of the returns. The first observations were made in the spring of 1969, but the first results were not ready to publish until a year later. Essentially what is measured is the reflectivity of that portion of the planet's surface passing through the beam at a given moment. The resulting maps are of dark or rough regions in a bright or smooth background. Goldstein said the contrast between bright and dark areas is less pronounced on Mercury than it is on Venus.

Gamma Rays from the Crab The Crab Nebula in Taurus, the throbbing remains of a star that was seen to explode in 1054, has been a rewarding subject for every new technique developed by astronomers. Using the first crude telescopes, Renaissance astronomers found the fuzzy cloud east of Aldebaran. Three hundred years later radio astronomers found one of the sky's strongest sources of radio emissions, and still later a pulsar, at that position. Astronomers using rockets have found an X-ray source there. Now, French astronomers using balloons have detected a source of gamma rays in the Crab.

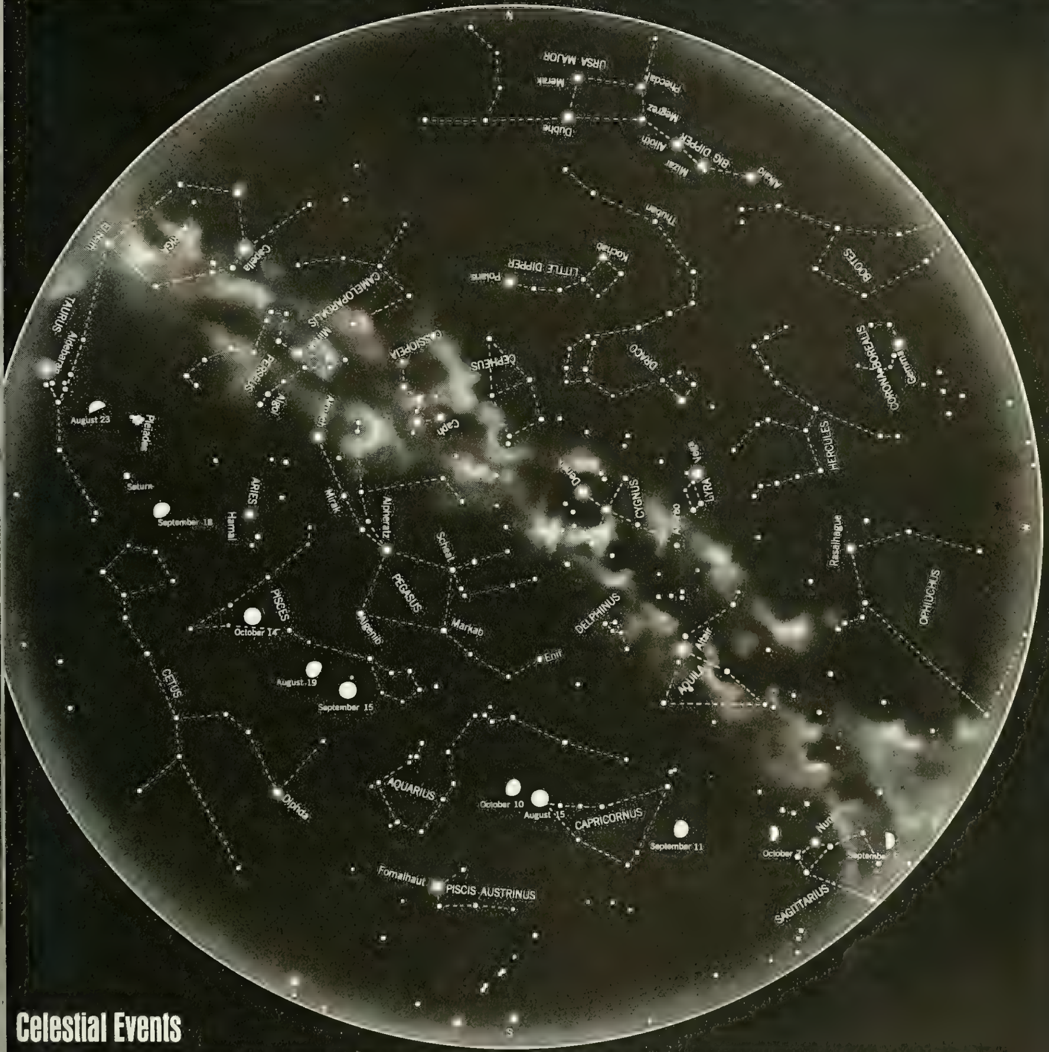
Gamma rays are the most energetic of the entire electromagnetic spectrum. The French scientists reported that those they discovered coming from the Crab appear to be pulsed 30 times a second, as are the optical, radio, and X-ray emissions. The nebula and the neutron star apparently pulsing in its center are thus the complete object for any astronomer, whatever his predilections.

John P. Wiley, Jr.

Partial Lunar Eclipse August 16 There will be a partial eclipse of the moon on the evening of August 16–17, visible at least in part throughout North America except in the extreme northwest. During such an event, part of the moon passes through the earth's shadow. The part of the moon in the shadow will appear dark, though with a faint copper-red light, for any observer on the nighttime side of the earth at the time.

The moon first enters the shadow of the earth at 10:17 P.M., Eastern Daylight Time. Maximum eclipse occurs at 11:23 P.M., when about 41 percent of the moon's diameter will be in shadow. The moon leaves the earth's shadow at 12:30 A.M. Times will be one hour earlier in Central Daylight Time, two hours earlier in Mountain Daylight Time, and three hours earlier in Pacific Daylight Time. Where standard time is observed, one hour should be subtracted from the daylight time.

Thomas D. Nicholson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Celestial Events

The moon is full on August 16, at last-quarter on the 23rd, and new on the 31st. In September, first-quarter is on the 8th, full moon (the harvest moon) on the 15th, last-quarter on the 22nd, and new moon on the 30th. There is a first-quarter moon on October 7 and a full moon (the hunter's moon) on the 14th.

Venus and Jupiter are evening stars, low in the west at dusk. Venus is the brighter and lower of the two, moving closer to Jupiter in August and early September. The two planets are nearest on September 14. In the morning sky, Saturn rises before midnight and appears high in the south at dawn; Mercury may be seen low in the east at dawn for several days before and after September 28.

August 16: Mercury is at greatest elongation in the evening sky, but too low to be seen easily.

August 23: Saturn is below the moon this morning.

August 31: The star near Venus is Spica, in Virgo.

September 1: Venus is at greatest evening elongation, but is not favorably placed for viewing.

September 4-5: The crescent moon passes near Venus and Jupiter.

September 23: Autumn begins when the sun arrives over the Equator at the autumnal equinox at 5:59 A.M., EST.

September 28: Mercury is at greatest elongation in the morning sky. The planet is well up by sunrise.

October 3: The crescent moon passes near Venus and Jupiter this evening. Venus is brighter, lower, and nearer the moon than Jupiter.

October 6: Venus reaches greatest brilliancy in the evening sky, shining at magnitude —4.3.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 12:25 A.M. on August 15; 11:20 P.M. on September 1; 10:25 P.M. on September 15; 9:20 P.M. on October 1; and 8:25 P.M. on October 15; but it may be used for about an hour before and after those times.

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Death by the Plow *Continued from page 35*

developed soon after glacial recession contained some prairie plants that extended their ranges eastward on the land left bare by the melting ice. Even if prairie plants were absent from this vegetation, it is possible that the vegetation was close enough in appearance and structure to that of prairie plants for some prairie animals to have found it to their liking and to have used it as a corridor to move eastward. The second possibility is that expansion of prairie occurred slightly later, at the time when conditions were becoming less and less favorable for spruce-fir forests; prairies, or some sort of herbaceous vegetation with prairie species, may have entered as a kind of wedge between the retreating conifers and the deciduous species migrating northward from their glacial refuges. Pollen diagrams show that beech did not reach northern Indiana until well after it was established in central and southwestern Michigan. Something made its migration northward through Indiana slower than its movement westward from the Alleghenies. If that something was the Prairie Peninsula, it is older than the xerothermic period. There is also evidence of the early presence of grassland animals in the east. In Pennsylvania, fossil deposits of a prairie mammal, the thirteen-lined ground squirrel, and a prairie bird, the sharp-tailed grouse, have been dated back 11,000 years, according to radiocarbon tests.

Another unresolved problem is the role of fire in the formation and spread of prairie. Fires were involved in the maintenance of prairies in the east at the time of settlement. Either naturally set by lightning or deliberately or accidentally set by early man, fires may also have been involved in the prairies' establishment. The old saw that you can't have a prairie fire without a prairie is true enough, but it is also true that the fire could open up a forest—either the deteriorating conifer forests of the early postglacial period or the beech and maple forests of a few thousand years later—and allow the entrance of prairie species that could perpetuate themselves.

We cannot now be sure whether burning was still spreading grassland at the expense of forest in the early 1800's or whether, under the climate of that time, the hazels and oaks were edging in, narrowing the prairies year by year and century by century. As likely as not, the latter was true, and the prairies of the east were on their way to a slow extinction. In any case they are gone now. In a prairie graveyard on Prairie Ronde there is a tombstone that reads:

> D-Sept 10, 1872 aged 76 yrs 6 mo 8 da He plowed the 1st furrow & raised the 1st wheat on this Prairie or in this county. Do not say that I have said, or done, to much or to little, for the absent can not reply.

The absent cannot reply, but neither must they deny the living the right to recognize and profit from the mistakes of the past. The time is gone, if it ever existed, when "he plowed the first furrow" was an unqualified commendation. The pioneer philosophy that inspired the epitaph must be modified if the natural landscapes that still remain are not to go the way of the eastern prairies. ■

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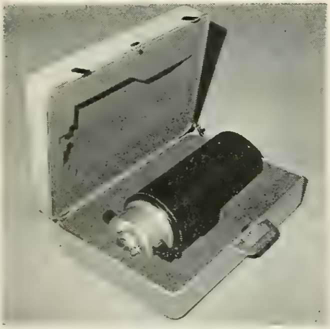

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sliding back down. And now prophets of disaster are talking about a new Ice Age by the year 2000.

Might man be inadvertently responsible for this reversal? Reid Bryson is one of the scientists who does not discount the possibility. He suspects that the decrease in temperature may be caused by a layer of dust gradually building up in the stratosphere—dust that is reflecting more and more of the solar energy that would otherwise reach the earth and warm it. In short, this cooling effect would work counter to the greenhouse effect. Bryson admits that he is raising a highly provocative hypothesis based on scanty evidence. But his measurements show that atmospheric turbidity—dustiness—is definitely increasing all over the world, and he can cite climatological records to show that after periods of violent volcanic activity, when eruptions throw great quantities of dust high into the atmosphere, average worldwide temperatures drop until the dust has time to settle. "The point is," says Bryson, "that man is now the equivalent of many continuous volcanic eruptions."

He suspects that most of the dust layer comes from agricultural rather than industrial sources, but adds that it could include all sorts of "junk" from varied sources. The problem is primarily one of overpopulation with a general increase in all sorts of human activity. Much of the dust probably comes from agriculture in semiarid areas of China, India, and Africa. Samples of atmospheric dust taken both in India and on the island of Barbados, where the dust has crossed the Atlantic from Africa, carry strong traces of DDT and contain phytoliths, tiny deposits of silica that form in the leaves of plants. Bryson regards this as pretty good evidence that the dust is largely agricultural in origin.

He admits that the rest of his theory—the effect of dust on global temperature—is highly speculative, and hopes that it will receive more examination by researchers than it has so far. He is concerned with

ky Show *Continued from page 97*

the same point that troubles Roberts, Schaefer, and most of the other scientists who are afraid that man is unsuspectingly modifying weather and climate. They feel that we don't know what we are doing to the atmosphere, and that we're not trying hard enough to find out.

Dr. Thomas F. Malone, a highly respected spokesman for the atmospheric sciences community, stated this viewpoint vigorously during recent congressional hearings. Asking Congress to support more comprehensive studies of technology's effects on the environment, he cited the greenhouse theory: "The important consequence is that if this goes on for 1,000 years, the sea level will rise about 400 feet, or about four feet per decade. This can happen. We are not sure. Special committees of the National Academy of Sciences, the National Science Foundation, and Congress have pointed out this hazard, as they have pointed out an alternative hazard, that an increase in particulate matter may have the effect of cooling off the atmosphere, and we would then be in danger of entering a glacial age."

Dr. Malone went on to explain that we have sufficient scientific knowledge as well as the technical resources to evaluate these threats, if we will take them seriously enough. "We understand enough about the physical processes to cast them in mathematical forms. We have the computers to solve the mathematical equations. We have the satellites and the observational equipment to bring the worldwide carbon dioxide content and weather patterns under surveillance. And these three things give us the capability to simulate what will happen if the carbon dioxide increases by so much, or if the particulate matter increases by so much. These two forces may work in opposite directions, but we do not need to wait fifty or one hundred years to find out what is likely to happen. . . . For three million years we have been trying to protect man against environment. It is now time we began protecting environment against man."

"Its purpose is to be. Man's role should be ...let it be."

A young ecologist shares the impact of a long and arduous walk through the Arctic wilderness: an expedition into the threatened, vanishing glories of Alaska's Brooks Range — crossing the Arctic Divide and the unexplored tundra to the Arctic Ocean. "The feelings evoked in the reader by what may be final glimpses of the unspoiled Alaskan mountain wilderness," writes the advance reviewer in *Publishers' Weekly*, "inevitably echo the author's implicit and explicit plea to keep this region as it is . . . a living solitude beautifully worth the rugged journey."

Justice William O. Douglas writes: "This journal puts us all on notice of the unique wilderness about to be mutilated by an oil pipeline . . . Oil has values; but so do caribou and lichen floor litter, grizzlies, wolves, Dall sheep, and the host of animals in the food chain . . . Will the people accept supinely the mutilation of this, our last pristine arctic wilderness?"

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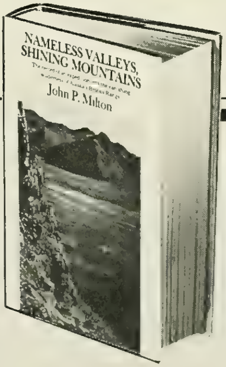

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An Island Consciousness

by Barbara Blau Chamberlain

Cape Cod and the Offshore Islands, by Walter Teller. *Prentice-Hall, Inc., $8.95; 256 pp., illus.* Martha's Vineyard, photographs by Alfred Eisenstaedt; text by Henry Beetle Hough. *The Viking Press, $8.95; 96 pp.*

In how many hearts is there a corner set aside for islands? Where else in our potential for experience—except perhaps the lifeless lunar surface—ride any hopes of escape from a world we should not have made, but did?

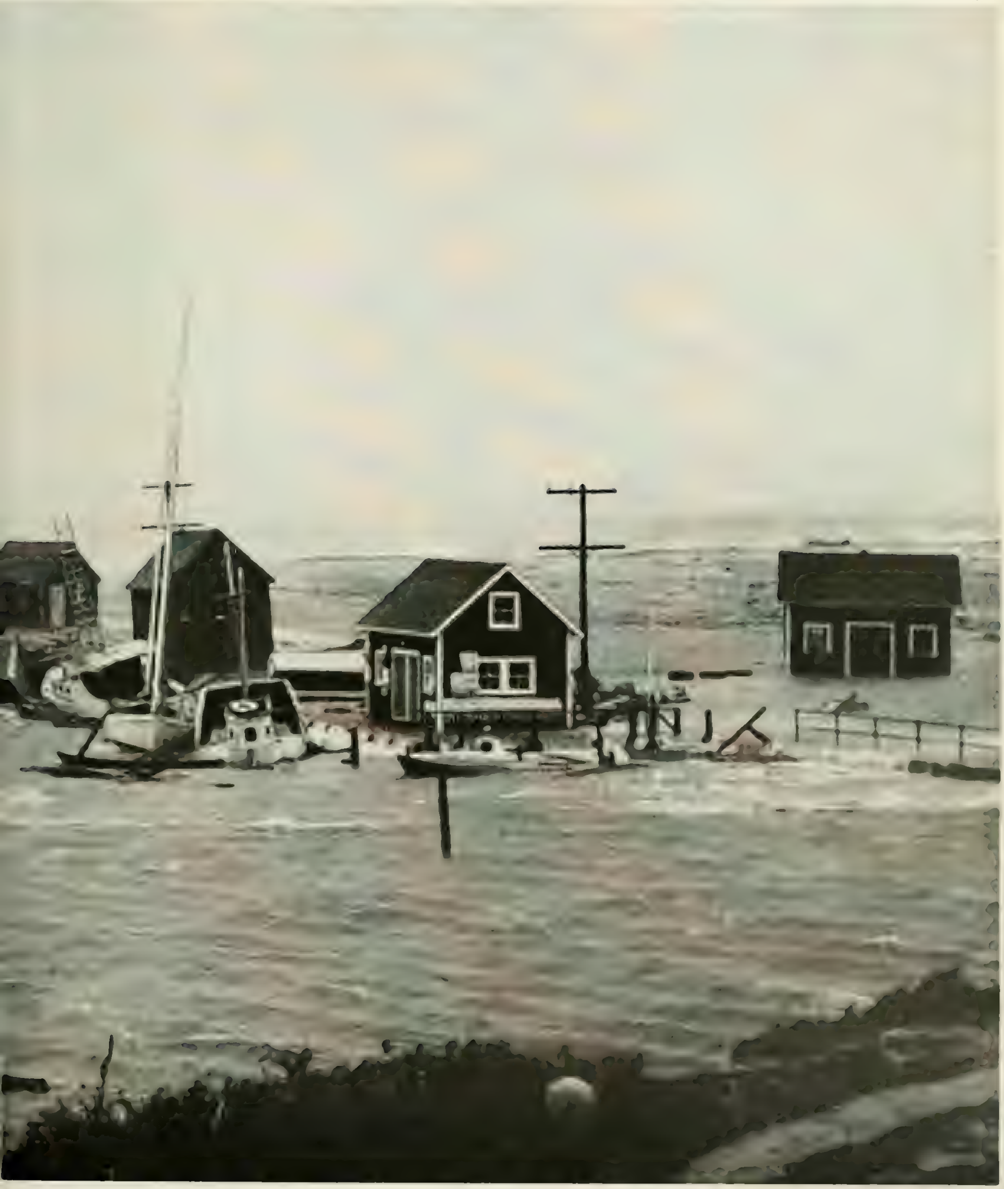
The books written about the much-loved sandy islands off Massachusetts would fill a long shelf, and two more might easily prove repetitive. But these are sufficiently different from what has gone before not only to stand on their own but also to fill gaps in the Cape-Island literature available until now.

Hough's *Martha's Vineyard* concerns itself wholly with Martha's Vineyard, of course. Teller's *Cape Cod and the Offshore Islands* covers the entire group, down to the tiny Elizabeth Islands, heretofore rather neglected in regional accounts. Each is an island book.

As an island, Cape Cod is a latecomer. Born a peninsula, it became an island with the building of the Cape Cod Canal. Although ties to the mainland are close and you can get there on macadam, you may still walk a Cape Cod beach and be twenty miles at sea. Martha's Vineyard, smaller and completely adrift off Cape Cod, is a full-fledged island of sufficient size and variety to know both rolling pastures and rolling seas. Nantucket, smaller yet, the far-away-land, is influenced solely by the sea. The tiny Elizabeths, strung out from southwestern Cape Cod, are for the most part blessedly unpopulated and a haven for birds.

Neither book is, in any sense, a rehash of the old tourist guide—cutely written, riddled with "quaints," duly illustrated with old mills and mani-

Menemsha in the hurricane of 1938.
From Martha's Vineyard



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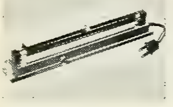

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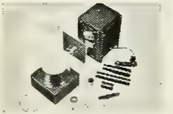

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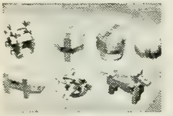

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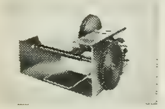

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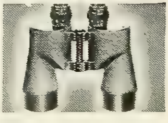

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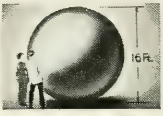

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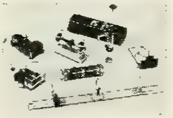

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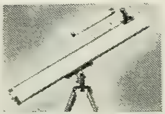

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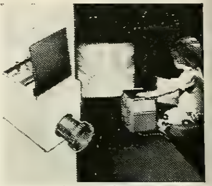

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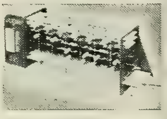

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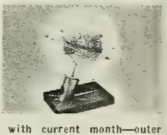

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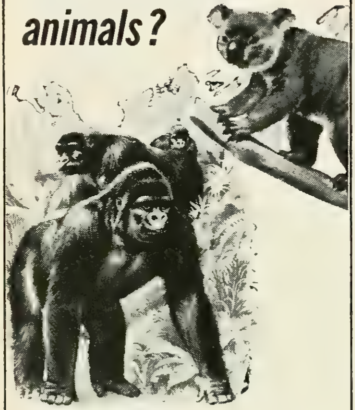
From Cape Cod and the Offshore Islands

cured village greens and, perhaps, a bit patronizing. Neither is a guide at all. Read the two of them, linger over the lovely and apt photographs, and you will experience the Massachusetts islands in a way that has seemed unattainable in print since Thoreau. These books are not the wine list; they are a sip of the wine.

The authors differ enormously in their approaches, so if you can read the two as a unit, an interesting dimension will be added. Unfortunately neither book has an index, which is inexcusable in works of this sort.

Teller's book gives the impression that the author remains the informed outsider, the knowledgeable summer resident. His is the summer home on Martha's Vineyard; he has another home and other interests the rest of the year. This leads to a summertime point of view rare in many earlier books. How well I remember my own young years as a "summer person" on Cape Cod. Only a Cape summer was conceivable; winter, fall, or spring were haunting concepts—magical, unthinkable, unattainable. Could a work-a-day year exist? Later we became year-rounders, and I came to know Cape seasons well. The prosaic conquered. The winter beach re-

Will our children live in a world without animals?



THE WORLD'S
VANISHING ANIMALS

By Cyril Littlewood, Director, Youth Service, World Wildlife Fund. Foreword by Thomas L. Kimball, National Wildlife Federation

It's hard to believe that within a few years many of man's favorite animals may vanish forever. Since 1900, over one hundred species of wild animals have been wiped out by the ruthless exploitation of nature. Today over 1,000 more are on the danger list—not just from hunters, but from the deadly pollution of their natural environments. Cyril Littlewood leader of the urgent campaign to save the wild animals that remain before time—and space—run out, describes here the physical characteristics, ecological environment and habits of 75 mammalian species that are rapidly disappearing from the earth: the Polar Bear, Panda, Cheetah, Otter, Wild Horse, Gorilla, Coala, Orang-utan, Indian lion, many others. Each animal is located on a fascinating map according to its origin and where it may be found today. 64 huge 8¼" x 11¼" pages. *Every animal is superbly illustrated in full color by E. W. Ovenden. For every copy sold, the publisher pays a royalty to the World Wildlife Fund to aid in preserving wildlife throughout the world.*

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mained a thing of beauty, but no longer was it a thing of magic.

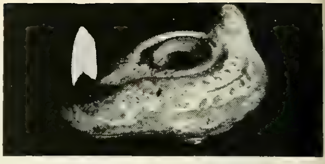
Whatever I lost, Teller still has. Of course, he is far removed from the naïveté of a teenage girl. But his descriptions of the off-season Cape and the islands are receptive, open, enthusiastic. At one point a lingering patch of snow on the beach compels him to snap its picture, since it would be hard to imagine snow on the sand in summertime.

Since Teller is not fiercely protective of, or emotionally tied to, the region, he remains unhindered. What he sees, he reports. He acknowledges the lobster shack with its "Native Lobster" sign, but does not ignore the disquieting "New Homes" sign near it and very near the marshes. Ambling here and there, we move with Teller from island to island, talk to all and sundry, not just about Cape-Island charms but about problems, too. Fact and history blow our way, lore of the sea and life of the land. Apparently a lot of research has gone into this book.

Unfortunately, sometimes the factual passages have the dutiful ring of a required—and somewhat hastily researched—school report. His personal observations, free and pleasant, are much more fun to read. However, too much subjectivity can become a little annoying. At times it almost seems as though Teller is trying to out-Thoreau Thoreau, and this can drag a bit. In addition, perhaps it is excessive to devote the better part of a chapter in a broadly-based book such as this one to Capt. Joshua Slocum, who was the first, as far as we know, to sail the world alone. Teller is an expert on Slocum, and his interest is understandable. Another chapter, more justifiably, is devoted solely to Vineyarder Nancy Luce, a more unusual Vineyard product than Slocum. Many have sailed the world alone, post-Slocum. But Miss Luce's heartrending poems to beloved chickens anticipate the simple elegance of Robert Frost by three-quarters of a century:

> "She opened her eyes and
> looked up into my face,
> For the last time.
> O heart melting. . . ."

On the whole, certainly, the Cape and Islands become very vivid under Teller's pen. And the most appealing aspect of his Cape-Island ramble is a very real sensitivity to nature and its precarious existence under the dread hand of man. The land developer, the marsh dredger, the polluter on Cape Cod and the islands are not ignored. Indeed, one developer is interviewed,



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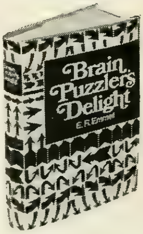

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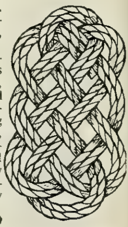

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noneditorially, and others discussed. They do not always come up roses. All the good intentions in the world about pleasant life styles cannot bring back one acre of ravished marsh nor, indeed, one family of bulldozed nestlings. And it is happening:

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A Vineyard book such as this has been needed for some time; this one is a good one. Eisenstaedt's photographs are a joy, and the text is a fine partner to them. A charming, thematic thread leads us through an island year, beginning with early spring. Woven around this thread is the colorful and solid fabric of the

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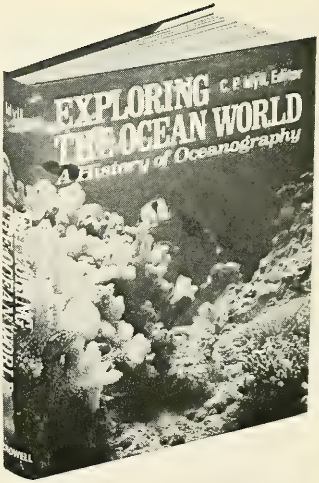
From Martha's Vineyard



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book. Did you know, for instance, that Shakespeare's *Tempest* might have taken place on Martha's Vineyard, about which Shakespeare may have learned from Gosnold's accounts? And that Ariel may have been the spirit of peeping pinkletinks (tree toads), while cruder Caliban may have emerged from cacklings of the heath hen? Far-fetched, no doubt, but fun to contemplate.

Thus range the subjects in this book, broadly and ramblingly. Since each town receives descriptive and historical homage, it more nearly approaches a guidebook than Teller's book; yet it is not that either. It is about seafaring and whaling, campgrounds and landscapes and legends. It is, simply, what the name implies: Martha's Vineyard. Hough keeps himself in the background and the Vineyard up front.

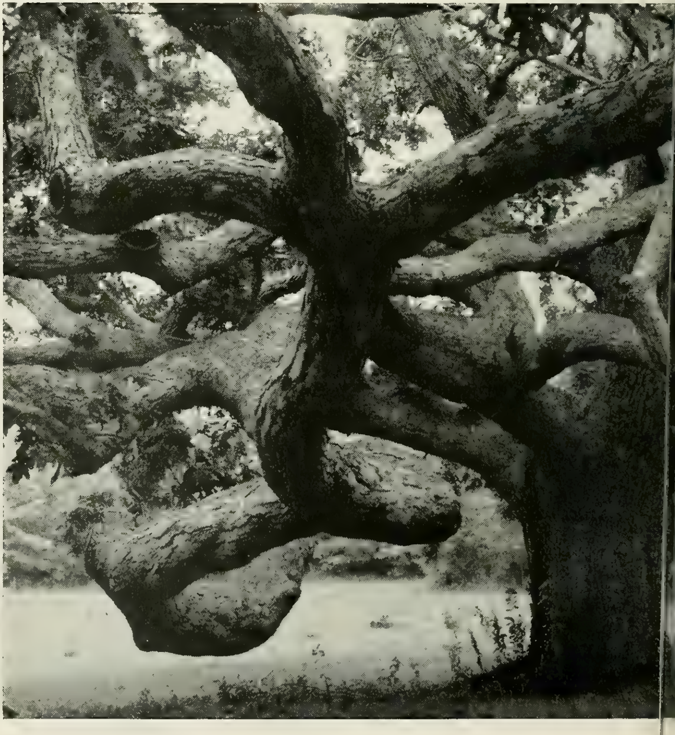
Perhaps the book could have been more evenly divided between humanistic and naturalistic concerns. Nature is not neglected by any means, but seems to take second place. Some of the historical facts seem so esoteric as to interest only those fairly intimate with the region. Yet the author shows himself so sensitive to the natural surroundings that we wish he had given us more of them:

Early April: "The sun's warmth, quickly gaining, becomes mingled with the chill of the clear night past and the cold breath of the waters around the island, producing once again a long-remembered experience of renewal. Vineyard Sound lies in streaked idleness, in an elongated pattern of lighter and darker shades of blue expressing the will of the tides, the early light, and the gentleness of a new spring."

Like Teller, Hough sees the threats. Despite the rapid erosion of the Vineyard's outer shores, he recognizes that, not nature, but man is the ultimate danger—"man's haste, indifference, ignorance, laziness and greed." Would that he had stressed the problems more strongly, for they are issues that need to be sounded relentlessly by leaders such as himself.

What of Hough's own statement: "Now there are no islands anymore." A terrible thought! Perhaps only the passing of the frontier offers an analogue in terms of a geographical effect on man's spirit. Yet, as both these books show, an island consciousness still drifts with the sea breezes across

Giant Oak.
From Martha's Vineyard



Cape Cod and the offshore islands.

Certainly there are no islands anymore, off Massachusetts or anywhere else, in the old sense. For better or worse, insularity is no longer synonymous with isolation. Certainly those tentacles of progress—power lines and gasoline hoses—have islands tightly within their grip. Certainly the glass and tin and ghastly inert plastic, effluvia of an affluent world, line island beaches no less than mainland beaches. Certainly island gardeners use chlordane as lavishly on their posies as mainland gardeners—although Massachusetts has stopped this. But a modified islandness—a bit of the sense of dreams attained—still clings.

Islands are not safe, their survival not assured. Cape Cod and the offshore islands, within easy reach of large metropolitan centers and bordering an expanding megalopolis, are in a precarious position. The miracle is that their insularity has survived at all. Now their preservation is dependent on some rapid action on the part of many people—including those whose immediate financial interests might lie elsewhere. They are worth saving, these islands and their

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Barbara Blau Chamberlain is the author of "These Fragile Outposts: A Geological Look at Cape Cod, Martha's Vineyard, and Nantucket."

HUNTING FOR DINOSAURS, BY Zofia Kielan-Jaworowska. *The MIT Press, $7.95; 177 pp., illus.*

Among the most famous and significant series of fossil hunts ever carried out were the Central Asiatic expeditions of The American Museum of Natural History, which probed the Mongolian desert for dinosaurs, other fossil reptiles, and varied fossil mammals during the 1920's. In 1946, a young Polish student of paleontology, Zofia Kielan-Jaworowska, read about the work of The American Museum expeditions and was completely fascinated by what she learned. A decade and a half later, she led a series of similar expeditions into Mongolia, to continue the search for fossil reptiles and mammals. In this modest but attractive book she gives a lively account of these expeditions and of some of the results that were obtained. It is good reading, written with authority and made especially effective by attractive and well-chosen field photographs.

After the war, Soviet paleontologists made three expeditions into the Gobi, to supplement and expand the pioneer work of The American Museum expeditions. In 1961, it was decided that the Polish Academy of Sciences, working in cooperation with the Mongolian Academy of Sciences, would conduct a series of expeditions into the desert to continue the search for new paleontological knowledge.

A first expedition was made in 1963 to survey the region and collect preliminary information. This was followed by two large-scale efforts in 1964 and 1965, the purpose of which was to search for and collect fossils, no matter what the difficulties might be. And there were difficulties, as there are bound to be for those working in remote desert regions—the heat in the daytime, and the cold at night, the ever-present problem of water, the high winds and sandstorms,

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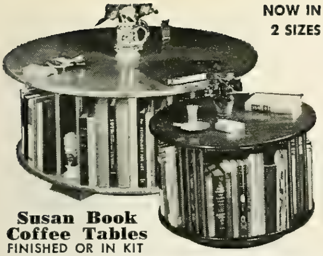

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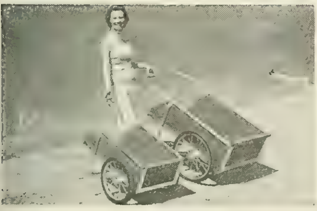

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and many lesser irritations. Moreover, there were the problems of collecting large and heavy fossil skeletons, of which these expeditions found numerous examples.

The manner in which the Polish scientists carried on their work and solved the many problems that beset them is interestingly recounted by Miss Kielan-Jaworowska. She also devotes numerous asides to descriptions of the Mongolian people with whom the expeditions had contact.

The Polish-Mongolian expeditions were successful, to say the least. Their success was due in large part to hard work by the dedicated and well-trained members of the expeditions, and to the use of good equipment. They traveled in sturdy field cars and heavy-duty trucks, and they camped at various localities in the Gobi. Their greatest collections were made in the Nemegt Basin, a great depression occupying southwestern Mongolia, and at the Flaming Cliffs of Bain Dzak, or Shabarakh Usu, where The American Museum expeditions had collected dinosaur skeletons and eggs and a number of early mammal skulls.

In the Nemegt, Miss Kielan-Jaworowska and her colleagues found several skeletons of the large Cretaceous tyrannosaur, *Tarbosaurus*, as well as skeletons of birdlike ornithomimid dinosaurs. But their most spectacular discoveries were of a huge sauropod dinosaur, which was most unexpected at this late stage in the Mesozoic history of Mongolia, and of an amazing theropod forelimb, nine feet in length, with claws a foot or more long. At Bain Dzak the Poles and their companions found a series of Cretaceous placental mammal skulls, to supplement the original discoveries that had been made by The American Museum parties. All of these discoveries by the Polish-Mongolian expeditions greatly broaden our knowledge of life in Mongolia during the final stages of the Age of Dinosaurs.

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THE DEATH AND REBIRTH OF THE SENECA, by Anthony F. C. Wallace. *Alfred A. Knopf, $8.95; 384 pp., illus.*

Anthony Wallace combines the best of anthropological and historical method with a style that commands fascinated attention. *The Death and Rebirth of the Seneca* is a "warts and all" picture, so unsparing of truth with regard to bloodcurdling customs of warfare and torture as well as to instances of individual venery and frailty as to make even more compellingly credible the truly epic

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drama, nobility of philosophy, perceptiveness of world view, and shrewd *Realpolitik* of the Seneca people.

The book opens with a prefatory account of a typical Six Nations Meeting as first observed by Wallace in 1951 at the Allegany Seneca Reservation in western New York. The meeting is really a four-day ceremony inspired by the message preached by the Seneca prophet Handsome Lake at the turn of the nineteenth century, when the fortunes of the Iroquois were at their lowest ebb. As detailed in Part I, "The Heyday of the Iroquois," the Five Nations of Seneca, Onondaga, Cayuga, Oneida, and Mohawk had joined together as a League of Peace under a much earlier prophet, Dekanawida, whose teachings had welded these colingual, but sometimes mutually hostile, tribes into a well-organized confederacy against their common, native enemies. With the coming of Europeans, the league benefited immensely—in material terms—from trade goods. Playing an astute political game, it carefully maintained the balance of power between the French and British in their long struggle for sovereignty over northeastern North America. About 1720, the league expanded and became the Six Nations when the Iroquois-speaking Tuscarora, fleeing north from the incursions of the Virginia colonists, sought its protection.

Ethnographic descriptions of the Iroquois go back more than a century, and Wallace selects skillfully from this vast literature, detailing where details are pertinent to his story and referring the more curious reader to appropriate works on subjects he treats in passing. He dwells particularly on the rich cosmological and ritual life created by the Iroquois, which persists in recognizable form in the ceremonial cycle of the modern Iroquois.

Part II. "The Decline of the Iroquois," actually covers the last of the heyday from a political and historical perspective, showing how Iroquois power—dependent on the fur trade and the constant playing-off of Britain and France—began to decline with the ascendancy of Britain and the expansion of the settlers' frontier. With the defeat of the French, the restive American colonists loomed as a new power to manipulate in the Iroquois interest, but the league could not make common cause in readjusting the play-off system. On the eve of the American Revolution, the league agreed officially to the urging of both the British and Americans to stay out of what was essentially a "family fight" among English brothers. However, as the war pro-

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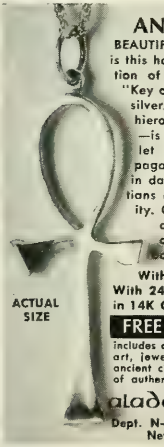

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gressed, neither side could afford to insist that the Iroquois observe this policy. Both sides found allies among the Six Nations. With American victory, the British supporters—mainly Mohawk, but including a scattering of forces from all the tribes—fled to Canada while those who had fought at the side of the Americans or had kept the neutrality remained in their homelands to become increasingly impoverished and demoralized. Deprived of the political strength of the league, they were unable to hold their separate tribal lands safe from squatters and land speculators. That any land remains to them at all probably reflects the shrewd negotiations of the practiced Iroquois, who during the darkest times managed to retain a few tracts and parcels in Canada and New York State through successive treaties and land sales after the revolution.

The final section, "The Renaissance of the Iroquois," is devoted to what Wallace designates as the apocalyptic and social gospels of Handsome Lake and their effects through the nineteenth century. Up to this part of the book, Handsome Lake is noted only in passing references to his participation in events, or knowledge of them, during the period of Iroquois decline. In the last part he emerges as a central personality. However, the charisma attached to his memory in his later years, from about 1799 to his death in 1815, prevents even Wallace from presenting him fully as a person. It could not be otherwise, of course, because it was his role as prophet and reformer, rather than the man himself, which revitalized first the Seneca and then all the Iroquois.

Today, nearly a quarter of the Iroquois are declared followers of Handsome Lake's religion, while the rest generally respect his Code and many avail themselves of opportunities to hear it recited. Crises produce prophets such as Handsome Lake but, as Wallace has shown in his earlier works, a successful revitalization movement is dependent on dedicated converts; institutionalization and reformulation of doctrine, making it practicable and perpetuating it beyond the lifetime of the prophet; and demonstrable "truth" in the message that things do get better if people abide by the doctrine. Handsome Lake's effectiveness as a prophet permitted his followers to take advantage of opportunities to fulfill the prophecy of deliverance from threatened extinction as a people. Foremost among these opportunities was the happy fact that Quaker missionaries came among the Seneca at the crucial period when the reformed drunkard

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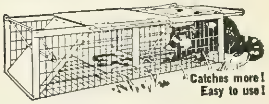

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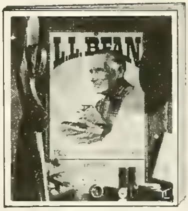

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When someone somewhere cares, someone somewhere survives.

emerged as inspired prophet. The Quaker philosophy, free of doctrinaire proselytizing and dependent upon good works and encouraging each individual to discover his own "inner light" in his own way, posed virtually no challenge to Iroquois values. The particular Friends who came to the Seneca proved to be unusually wise and perceptive men, appreciating the potential for good in Handsome Lake's preaching. They simply brought new technical means to replace an irrevocably shattered socioeconomic system, allowing the spiritual values of the Seneca to again give meaning and an ineffable richness to life. Handsome Lake did not seek to destroy or replace the old ways, but merely to reform them and to do away with the more recent errors in Seneca thinking and behavior, which he believed had brought them to their sorry state. His message made the old ways usable in a changing world and kept alive the sacred spirit and form of the league after it had ceased to exist as a viable political entity.

Then, suddenly, the book ends. Most readers will hope that Wallace now plans to write the story of the Seneca since he began field work with them in the 1950's, tracing the course of their protracted legal battles and final defeat in the courts, which decreed that the waters of the Kinzua Dam would rise over much of the Allegany Reservation. What has become of the Seneca and the tradition of Handsome Lake since the people were driven from their old homes in the alleged "national interest" for a "just compensation" in the materialistic terms of the white man?

NANCY OESTREICH LURIE
University of Wisconsin-Milwaukee

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The sanctuary itself is a sight for any so
eyed conservationist. It was established twent
seven years ago by Mr. Edward A. McIlhenny
member of the family that has owned the isla

s an oil field.

153 years. It had one purpose. To save the
wy egret from extinction.

Known as Bird City, the sanctuary started
h only seven egrets. Now, over 100,000 nest
und its man-made lake every year. To see
se alabaster birds sharing their Eden with
ons, ducks, coots, swans, cormorants, tur-
, deer and alligators is almost a primeval
erience. It seems to put the clock back to
beginning.

And, wherever you wander on this peace-
island, you have to look hard to spot the oil
ls. Many are hidden by grandfatherly oak
s bearded with Spanish moss. Others are
screened by banks of azalea and rhododendron. To Jersey's affiliate, Humble Oil & Refining Company, this respect for environment is only right and proper.

The oil industry provides Louisiana with one-third of its total revenue. But even this contribution would be a poor excuse for defiling beauty or disturbing wildlife.

Amen say the egrets.

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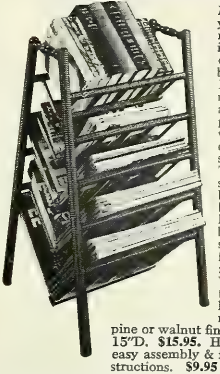

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Letters to the Editor

Barrier Beach Backwash

I was indeed most interested in your article "Barrier Beaches of Eastern America," and believe it or not, found time to read it the day it came in.

It was not only sensible, but very beautifully written. I only wish I could enjoy the luxury of looking at the problems of Fire Island geologically. The problems of Fire Island as they are presented to me are much more strident and immediate and demanding. There just isn't any way to make a man whose house is washing away appreciate the fact that this is "part of an ongoing history of physical change in which neither of the antagonists, waves nor beaches, gains a permanent victory." I guarantee you that any congressman who attempts this approach loses a permanent vote.

Otis G. Pike
House of Representatives
Washington, D.C.

While we do not take issue with Christopher Schuberth's main points in his article on barrier beaches, we were disappointed to find that some of the most vital points about the ecology of barrier beaches were overlooked or underemphasized.

We are referring to the mindless and endless construction of houses, beach clubs, tennis courts, marinas, bulkheads, discotheques, and parking lots, which are fast filling up the barrier beaches of Long Island, the Jersey shore, and the rest of the Atlantic coast as well. Barrier beaches are, it is generally believed, stabilized by vegetation. They have limited freshwater resources and a fragile ecology. In their wake, they produce that rarest and most valuable of natural features, the salt marsh. The marshes, bays, and lagoons formed behind barrier beaches are a unique and, by far, the most productive and valuable ecological environment on the East Coast south of Cape Cod. Yet countless acres of stabilizing beach grass and vegetation have been uprooted or asphalted over for house and road construction; countless wells have been, and are being, drilled into the limited freshwater resources; dredging, bulkheading, and filling proceeds apace on the bay side, eliminating thousands of marsh acres. In short, the whole integrity of the barrier beach is being violated more and more, day by day.

Serious and immediate thought ought to be given to the barrier beach problem, not in bits and pieces, not in terms of just the movement of berm and sand, but in some larger perspective. The whole ecology of the beach—from surf (or perhaps farther out) to interior bay—should be studied and treated

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as a whole. The public nature of the berm must be reaffirmed and the strongest possible action must be taken.

Eric and Lorna Salzman
Brooklyn Heights, New York

Barnard's Star

Dear Professor van de Kamp:

I was interested to read your article, "Barnard's Star: The Search for Other Solar Systems," in the April, 1970, issue of Natural History. I remember, from my visits o Swarthmore, that you had been working on this subject.

I was puzzled by one of the illustrations. This illustration [page 41], showing the wobble of the star, indicates a still greater wobble of the center of mass of the star and its two planets.

The last sentence in the legend also seems easily capable of misinterpretation.

I surmise that there really is a nistake in the drawing and that the lrawing was made by the illustrator, rather than by you; but there is he possibility that I have misunderstood the argument in some vay. My curiosity as to the latter ossibility has caused me to write o you.

Linus Pauling
Stanford University

The Author Replies

Dear Professor Pauling:

Thank you for your thoughtful etter. The legend is incorrect and nisleading. The best way to correct he confusion would seem to be a tatement like this:

The "planets" in the diagram epresent the gravitational effects ttributed to the inferred planets ather than the planets themselves. n fact, the planets are on the opposite side of Barnard's Star at distances some 150 times larger than hese effects.

I regret this error, which some-ow was not caught in time. And I

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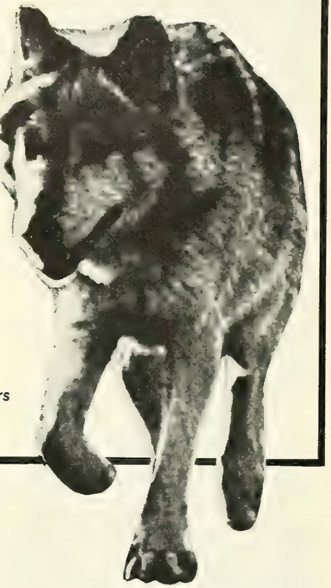

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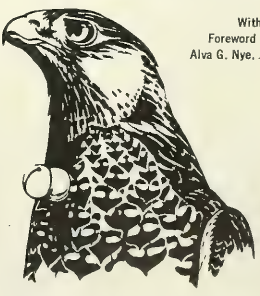

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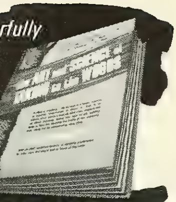

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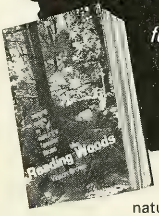

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appreciate the gentle manner in which you drew my attention to it.

We are continuing work on this star. I am terribly aware of the possible sources of errors that may affect these small deviations in long-range series of photographs. I am keeping my fingers crossed and intend to accumulate material "indefinitely." At the moment it seems to me that appreciable improvement in accuracy could be attained by remeasuring all the material on a modern measuring machine.

PETER VAN DE KAMP
Swarthmore College

Mushrooms, anyone?

In the June-July issue of NATURAL HISTORY Peggy Young has a long article on mushrooms that is notable for its dogmatic presentation. Not that she is necessarily in error, but I feel that the editor should not encourage such leanings. Or am I old-fashioned?

In his book "The Life of the Fly," Jean Henri Fabre includes some extraneous notes, including the French peasants' method of preparing mushrooms. Presumably poisonous types are boiled in salt water, then drained, before other cooking. Fabre ridicules the idea that the poisonous types should be learned and avoided. Has anyone else made a test?

WILLARD F. HOLLANDER
Professor of Genetics
Iowa State University

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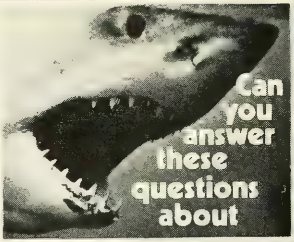

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True or false:

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C. *Shark skin is covered with tiny teeth.*
D. *Sharks are afraid of porpoises.*
(answers below)

If the answers to these questions surprise you, you will find a wealth of other surprises in THE NATURAL HISTORY OF SHARKS, by Thomas H. Lineaweaver III and Richard H. Backus. The scuba age has overthrown many cherished misconceptions about sharks: It has long been proclaimed that sharks must turn over to bite. (This one goes back to Aristotle). And naturalists who should have known better have often pronounced the shark weak and harmless.

Lineaweaver and Backus, both associated with the Woods Hole Oceanographic Institution, have assembled a complete survey of all that is known about sharks today. They include their own observations and those of others, from William Beebe to Marco Polo. Their book is copiously illustrated with photographs and drawings showing all the major species of shark. And it includes —for the fisherman or amateur naturalist—a complete key to quick identification of any shark. The price of this fascinating volume is surprisingly low, only $6.95. Order your copy today.

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BIG SUR STORM

Call Me Ishmael. C. Olson. William Morrow & Co., Inc., New York, 1947.

Between Pacific Tides. E. F. Ricketts, J. Calvin, J. W. Hedgpeth, eds. Stanford University Press, Stanford, 1962.

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Tuktu: A Question of Survival. F. Symington. Canadian Wildlife Service, The Queen's Printer, Ottawa, 1965.

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We know these programs work. One plan, with a Reynolds promotion drive behind it, has Los Angeles citizens bringing more than *a million cans a month* into our plant there. It has not made Los Angeles people m aware of their litter problem has *involved* them, stimulated th into doing something about i

Now we're expanding our Mi effort to cover all of Florida. W be launching our campaign in N York City, and will move i northern New Jersey, Houst San Francisco, and the Pac Northwest.

In addition, we are working Adolph Coors Company of C rado to help reclaim their u aluminum beer cans. We'l taking their cans from Arizo Colorado, New Mexico, Wyom Utah, Nevada, Kansas, Oklahc Texas, and California.

ed aluminum is valuable.

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comparison, brings only $20
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taking to a reclamation plant.
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pital charity groups, and other
anizations—and individuals—
e funds by collecting and re-
ning aluminum scrap.
hey're taking our suggestions.
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up in Los Angeles garbage heaps every month prove that.

Letters for anti-litter.

Our anti-litter efforts have brought us much applause from Boy Scout officials, Congressmen, Keep America Clean groups, civic leaders, and many others. But our chief satisfaction is in being able to help with this most difficult and important problem. We intend to keep at it, and to work even harder. Reynolds Metals Company, P.O. Box 2346-LII, Richmond, Virginia, 23218.

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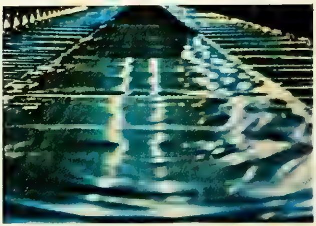
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And we're moving as fast as we can.

Because, like the fawn, we're all running short on time.

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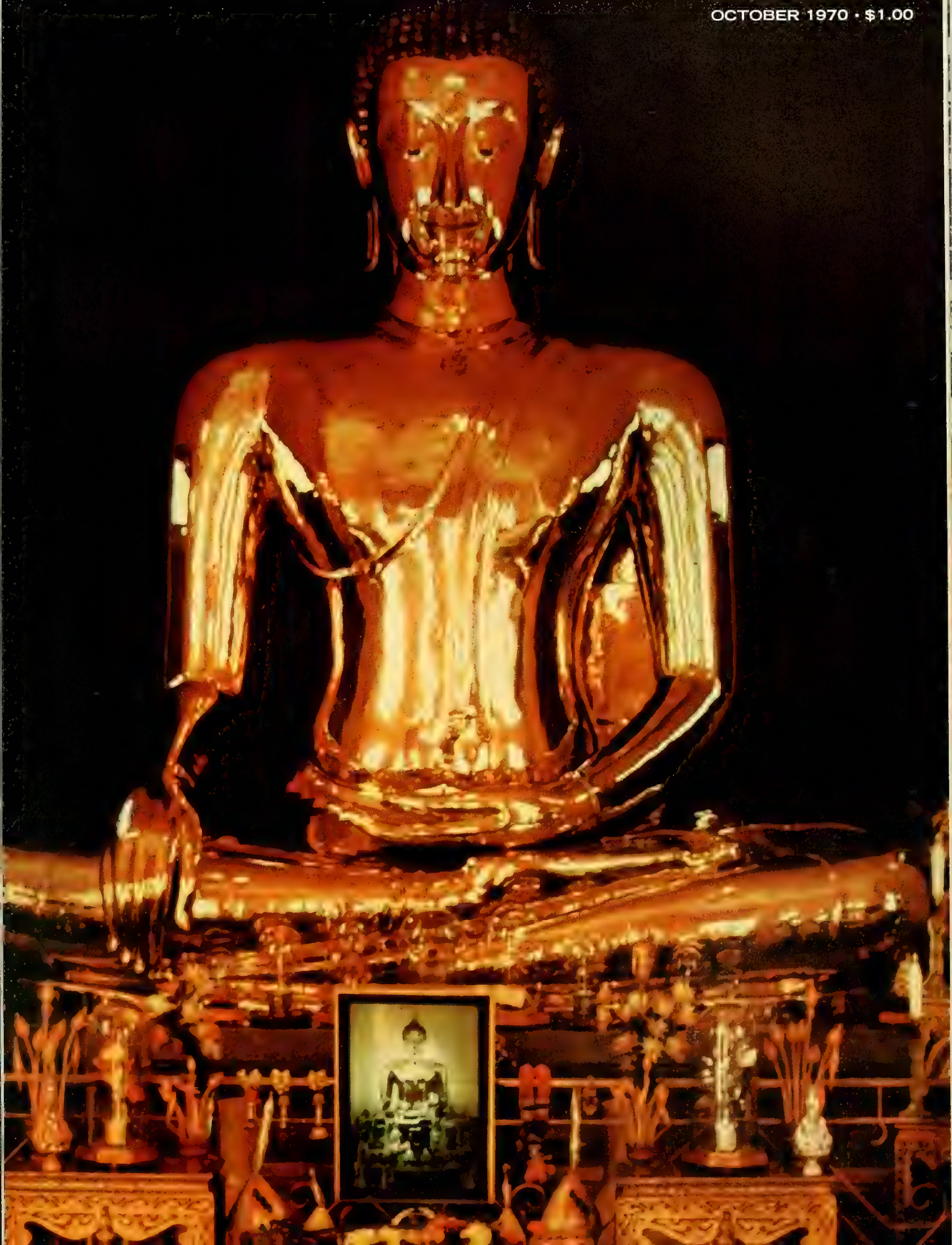

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NATURAL HISTORY

INCORPORATING NATURE MAGAZINE

The Journal of The American Museum of Natural History

Vol. LXXIX, No. 8 October 1970

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Publication Office: The American Museum of Natural History, Central Park West at 79th Street, New York, N.Y. 10024. Published monthly, October through May; bimonthly June to September, Subscription: $7.00 a year. In Canada and all other countries: $8.00 a year. Single copies $1.00. Second-class postage paid at New York, N.Y., and at additional offices.

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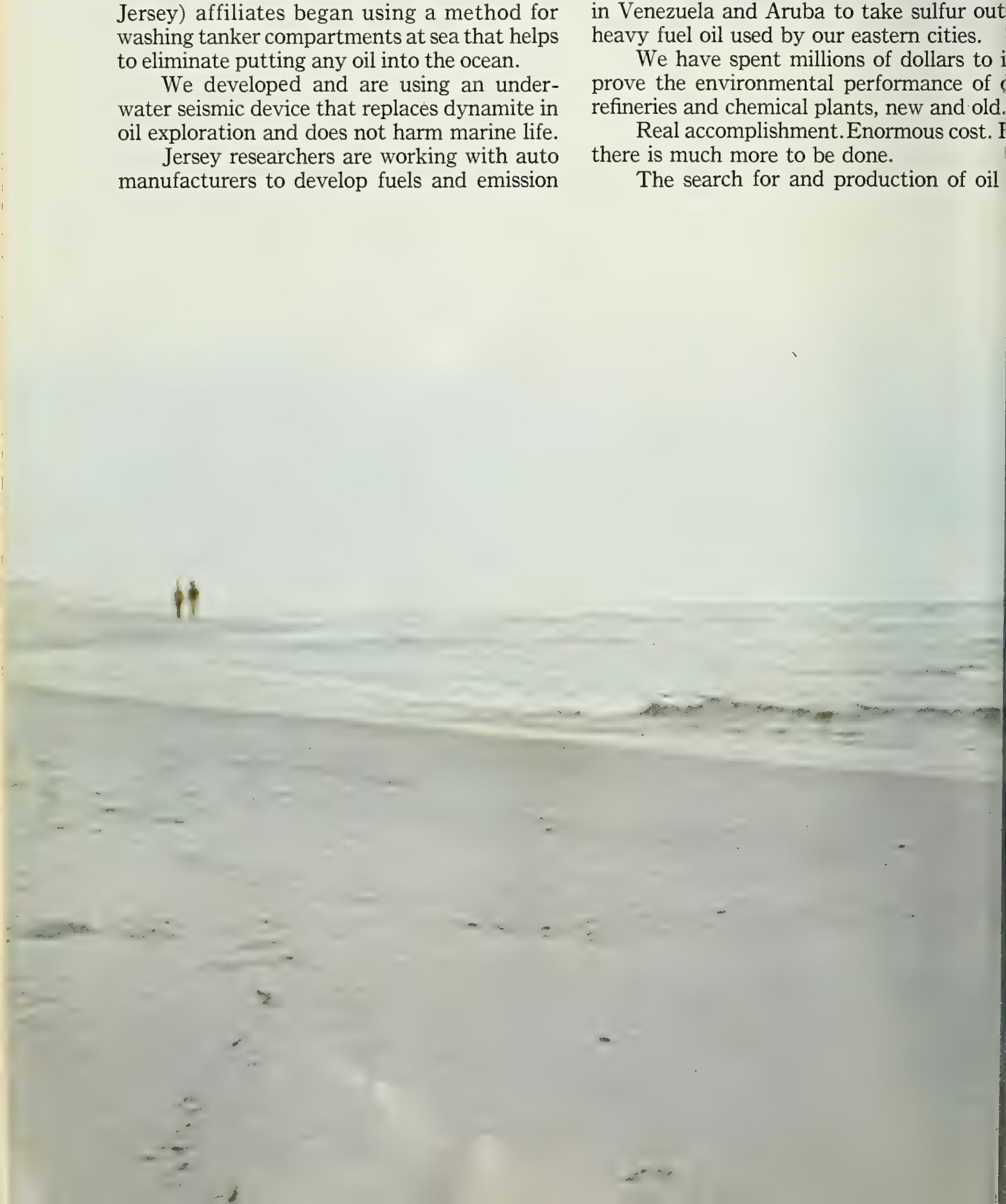

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ed by vigilant care for the ecology.

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n for ways to improve their environmental
ormance.

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t to solve our problems. But all industry,
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Authors

During his thirty-one years as a research biologist with the U.S. Fish and Wildlife Service **Victor B. Scheffer** worked primarily with mammals, especially seals and whales. The recipient of the Department of the Interior's Distinguished Service Award in 1965 and the John Burroughs Medal in 1969, Scheffer's field work includes the north Pacific and Alaska, where he studied marine mammals, England, the USSR, and Antarctica. He is the author of numerous articles as well as several books, including *Seals, Sea Lions, and Walruses; The Year of the Whale;* and *The Year of the Seal.*

A free-lance writer and photographer and an active conservationist, **William A. Bake, Jr.,** has combined these interests in a study of the granite outcrops of Georgia. A resident of northeastern Georgia, Bake is an instructor of educational media at the University of Georgia and newsletter editor for the Georgia group of the Sierra Club. He received his M.A. in American history from Emory University and is currently working on his doctorate in education. A member of the Georgia Conservancy, his articles and photographs have appeared in several national publications.

Associate professor of anthropology at the University of Washington, **Charles F. Keyes** has conducted extensive research on th peoples of Indochina, particularl the Thai. His field work in Thailand includes two years in th northeast studying village-nation relations, peasant social organizatio and peasant Buddhism; and a yea in the northwest region researchin Thai-tribal relations and ethn history. The recipient of a numbe of fellowships, Keyes is preparing book with Prof. A. Thomas Kirsc of Cornell on the anthropology Southeast Asia.

Can you pick out your Scotch?

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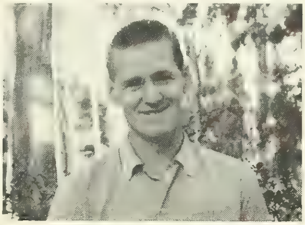
All Scotches shown above were photographed under identical lighting with equal proportions of whisky and ice, using an 8x10 Plaubel camera with

Professor of botany at Virginia lytechnic Institute in Blacksburg nce 1969, **Bruce C. Parker** re-ived his M.S. from Yale Univer-y in 1957, and his Ph.D. from e University of Texas in 1960. fter spending the following year University College, London, as a ational Science Foundation post-ctoral fellow, he became assistant ofessor of botany at the Univer-y of California, Los Angeles, in 61. Four years later he joined the aff of Washington University in . Louis as associate professor of tany. Author of numerous arti-es for scientific journals, Parker editor of *Contributions to Phy-logy*.

As a Fulbright research professor Ibaraki University in Mito, **Rodger Mitchell** spent a year in Japan studying the biology of water mites. During his stay, he collected many native toys and used them to encourage his Japanese friends to talk about their folk tales and traditions. Currently professor of zoology at Ohio State University, Mitchell's studies involve the analysis of the relations of parasitic mites to their host.



British-born **Geoffrey Burbidge** of the University of California, San Diego, has been a major force in strengthening the scientific foundation on which modern cosmology is based. A theoretical physicist, Burbidge accepted a Carnegie Fellowship to Mount Wilson Observatory in 1955. In 1962, after five years on the faculty of the University of Chicago, during which he and his wife made the observations from which they determined the masses of galaxies, he joined the faculty of the University of California, San Diego, as professor of physics. Among their many notable contributions to the field, their theory of the origin of the elements is considered to be a classic in astronomy. A fellow of the Royal Society and of University College, London, Burbidge plans a theoretical study of radio galaxies, quasi-stellar objects, and nuclei of galaxies.

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Wit, Wisdom, & Woe

A preliminary report on the replies to Natural History's questionnaire, "You and the Ecology Movement"

By Luther P. Gerlach and Virginia Hine

One characteristic of NATURAL HISTORY readers is their remarkable responsiveness. To date more than six thousand readers have returned the ecology questionnaire that appeared in the June-July, 1970, issue. The answers came from every section of the continental United States, from Hawaii, Alaska, Mexico, Canada, England, France, Argentina, and Pago Pago. Many readers duplicated the questionnaire form and distributed it to friends, neighbors, colleagues, or students. Two bundles arrived from high school teachers: one represented the total student body of one school; the other, the freshman and senior students.

Lengthy comments in the margins or in separate letters indicated lively interest in the questionnaire's subject matter. Such comments—some enthusiastically supportive, some sharply critical—add greatly to the information collected. Even though it increases the task of analysis and interpretation of the data, we are most grateful to those who took the time to make personal comments.

The mechanics of processing and analyzing all of these responses is so time-consuming that a full report of the results will not be published until a later issue. But interest in this project is such that a preliminary report, to you who have cooperated so willingly, is mandatory.

The most frequent comment accompanying the answer forms had to do with the advisability of printing the form on the back of a particularly charming picture of cheetahs. Some chided gently; others were outraged. The questionnaire at least determined clearly that a gratifying number of readers keep each issue of this magazine on permanent record.

The second most frequent type of comment had to do with the questionnaire itself. These comments ranged from "this questionnaire was just great" to "this questionnaire is not very bright. The answers are too bloody simple. Next time why not get pros to make up the questionnaire?"

Some respondents felt the limited choice of answers on the questionnaire was "unrealistically confining" or "an offense to the intelligence of readers." This is a classic reaction to multiple choice questionnaires—from census forms to college entrance exams. Everyone resents the implied uniformity of precoded questionnaires. It offends our sense of individuality. It also appears to reduce complex questions to simplistic answers. This is particularly true in areas of vital concern. When feelings run deep, they are not easily boxed into neat little categories.

The survey method, however, is one of the best for discovering general trends in the opinions of large numbers of people. Many readers commented sympathetically on the problems of a project of this nature. Two teams of social scientists trusted its validity sufficiently to ask for access to the data for use in their related research projects.

There were numerous criticisms of "bias," "lack of objectivity," and "loaded questions." The more irate of these critics viewed us as scientific "charlatans" or just "downright stupid," and suggested that in the future we submit our questions to a panel of experts. Actually, several months of planning and considerable expertise went into the selection and wording of the questions. The content of the questions was generated out of hundreds of personal interviews with people involved in conservation and ecology groups, as well as with people who actively oppose them. The statements and questions were phrased in terms that these individuals and groups used originally in

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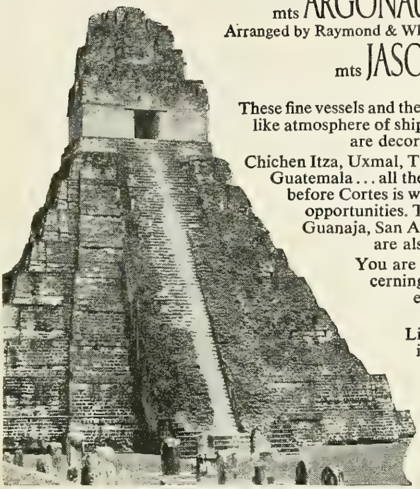

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discussing the issues. On such a survey, one aims for common terminology as it is popularly used, rather than for professional exactitude. The questions were then gone over carefully in cooperation with a team of psychologists doing similar surveys. This was followed by repeated pretesting with several groups of people who were invited to suggest changes in phraseology. Several items were also run in a Minnesota poll sponsored by Minneapolis newspapers. All items were then reworked so that the terms used would be commonly understood by the widest range of potential respondents.

The so-called slanting of some of the questions was intentional. Actually the items that drew most of this type of criticism were not exactly questions. They were statements. Furthermore, they were statements commonly heard among environmentally minded people of different persuasions. "Loading" for most people means that a specific answer is expected. There were no "answers" as such to these statements. There was an opportunity to express various degrees of agreement or disagreement with them. We neither expected, nor did we get, predictable concentrations of responses.

A review of the questionnaire will reveal that on controversial points half of the statements were loaded in one direction and the other half in the opposite direction. The purpose of this was to elicit precisely the value judgments so deplored by some of our critics. Emotionalism, they said, served only to muddy the waters.

It would be nice if human responses to serious problems were based solely on reason. It would be even nicer if environmental decisions were made solely on the basis of scientific facts. The assumption that our decision makers can operate without emotional bias is a wistfully held myth in our society. As one respondent put it: "The solutions of these [environmental] problems will be found through the use of our brains and not our emotions." Others wrote that emotionalism has no place in scientific investigation, and several took NATURAL HISTORY to task for no "sticking to the facts."

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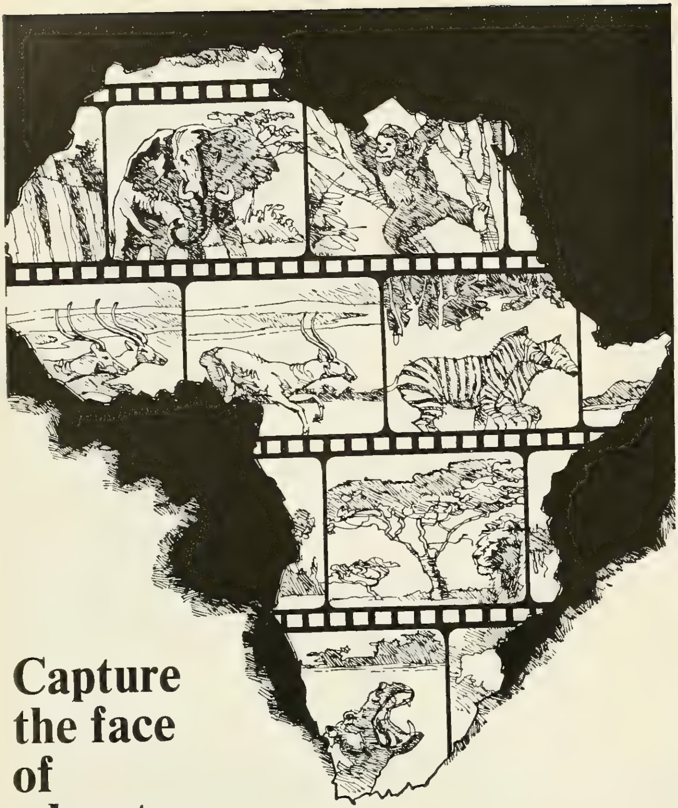

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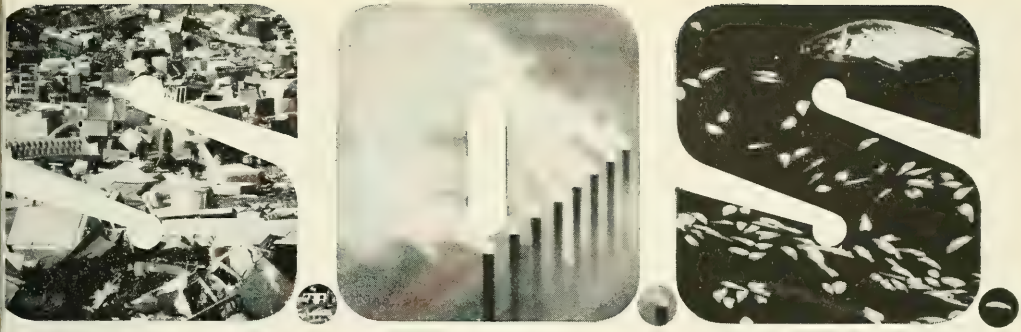
We might point out that environmental facts are only half of the equation—the easiest half to study. It is easier to measure the particulate matter in automobile emissions, for instance, than to measure the variety of human reactions to it. But one of the most crucial components in any ecosystem is the human decision-making process. Observation of environmental decision making in different parts of the country over the past three years indicates that human value judgments and the degree of emotion with which they are held are pertinent facts in the ecological crisis. These are the kinds of facts that the questionnaire was written to elicit.

One of the most interesting findings, even at this preliminary stage of the analysis, is the wide difference of opinion among NATURAL HISTORY readers on the relevance of political or economic issues to the ecological crisis. Here we touched a sensitive spot.

"I do not see, for the life of me, how the elimination of the profit system has any connection with ecology or pollution," wrote one respondent. Others resented the inclusion of questions about Black Power, campus movements, antiwar efforts, and religious reforms as irrelevant, if not positively "subversive."

These questions were included, not because the authors are "trying to force a connection between conservation and New Left politics," as one person suggested, but because many of the people active in conservation and ecology groups are already making these connections in their thinking. Extensive personal interviews have turned up many participants who view political, economic, religious, and other aspects of human life as interrelated in the same way that different species within a biological ecosystem are interrelated. We wanted to find out how widespread this view is among environmentally oriented people.

The preliminary tabulations indicate that a large majority of those who answered the questionnaire do view the various protest movements as related in some way to the conservation-ecology groups. Of these a sizable minority see them as not only related but as different aspects



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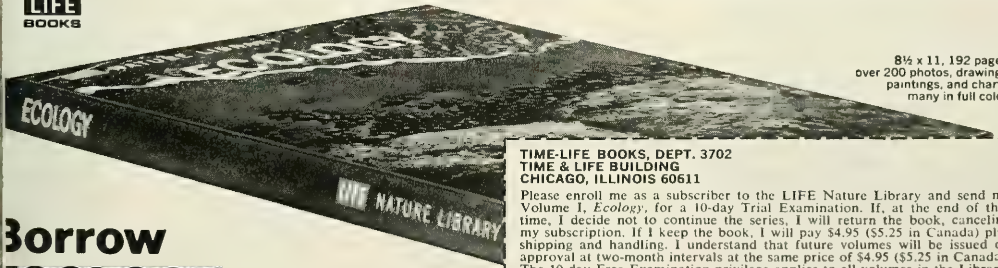

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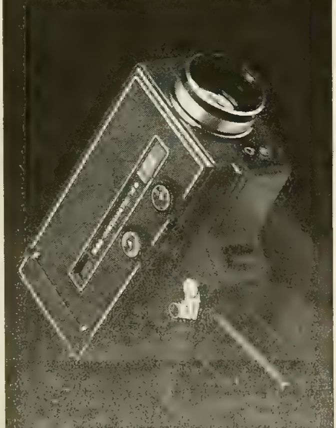

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of a single thrust for fundamental social change. Respondents were about evenly divided on the question of whether racism and pollution are part of the same or different problems. We were rather surprised by these preliminary findings.

It would appear that participants in conservation-ecology groups tend to practice what they preach. Respondents were very specific about changes in their behavior patterns that resulted from their new ecological awareness. The most frequently mentioned change in behavior had to do with buying habits. People are using fewer disposable products, refusing to use detergents and certain pesticides, avoiding plastics like the plague, rejecting no-return bottles, and leaving paper bags with the check-out girl. Many mentioned cutting down on the use of water and electricity, increased use of bikes, and walking more. Household waste-recycling practices are popular, and the World War II victory garden has reappeared as the survival garden. Litterers are frowned upon by all and personally accosted on the street by the more audacious. There were also reports of occupational changes into jobs more relevant to the ecological crisis. For some this has meant reduced salaries.

Population control has become a personal matter for some, especially those who are just beginning their families. The "stop at two" motto is apparently being taken very seriously. One reported an abortion as part of her ecological effort. Many older respondents who already have four or five children expressed support for the concept of population control, but as one father quipped: "What should I do with my last two children? Throw them away?"

Another factor that seems to be emerging is the pressure adults feel from their children. Children apparently are becoming outspoken critics of adult litterers. One teenager made life miserable for her mother until she stopped throwing vegetable matter down the disposal and started putting it on a compost heap. Another wrote that he "angers my parents' friends continually" by criticizing their environmental habits.

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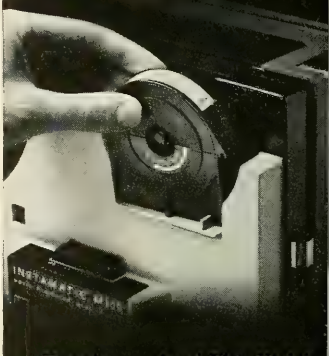

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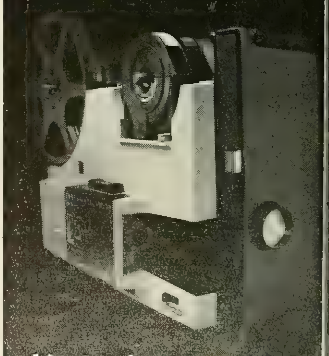

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One of the attitudes that we found prevalent in our personal interviews was also expressed by respondents to this questionnaire. Older conservationists pointed out that all the present hullabaloo about ecology only meant that people were beginning to catch on to what they have been talking about all their lives.

More than half of those active in the conservation-ecology groups approved of more activist methods of achieving their goals. A majority approve of rallies, demonstrations, marches, and even nonviolent direct action such as sit-ins in front of bulldozers. Clearly this approval is largely theoretical. It has not been tested by most, and only a small fraction of respondents reported having taken any risks in their ecological activism. But it might suggest an impatience with conventional methods of achieving environmental goals.

In conclusion, something must be said about the validity of what statisticians call the "sample." How representative are the responses of those who answered the questionnaire? As pointed out by one of our respondents, the people who answered this questionnaire are by no means representative of the general public. NATURAL HISTORY readers, she wrote, are "specifically conservation oriented." In addition, we might add, our sample is also characterized by a willingness to answer such a questionnaire, so that it may not be wholly representative even of all NATURAL HISTORY readers.

Analysis of the responses will allow us to understand much about this particular group of people. Our plans include giving the same questionnaire to other types of groups. It is being published, for instance, by *Industry Week*. Eventually, we will be able to draw comparisons between the responses of NATURAL HISTORY readers and those from groups who do not share a "specifically conservation orientation." We hope that these data will add to our growing understanding of our ecosystem, of which human society and the human decision-making process are such important components.

The following comments, selected from the thousands that were received, indicate the range of opin-

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The editors of Moneysworth are a team of hard-nosed, experienced journalists. The editor-in-chief is Ralph Ginzburg, creator of the flamboyant magazines Fact, Eros, and Avant-Garde. Mr. Ginzburg was the first editor to provide a platform for Ralph Nader to express himself on the subject of automobile safety. Moneysworth's publisher is Frank R. Brady, generally regarded as one of the publishing industry's shrewdest financiers. Herb Lubalin, the world's foremost graphic designer, is Moneysworth's art director. Together, these men will produce the first—and only—consumer magazine with *charisma.*

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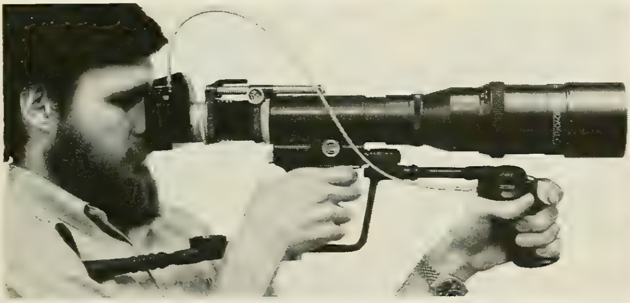

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ion and the great emotion that the questionnaire evoked.

The Questionnaire

Your questionnaire for readers of your magazine was most interesting and thought provoking. We have made several copies and have distributed them to other workers.

Your suggestion that the ecology movement, black power, and the "student rebellion" are interrelated is very disturbing to me. I think they have little or nothing in common except a feeling of urgency and frustration. The enemies of the ecology movement are trying to promote the idea that we are just another bunch of radicals. On the contrary, we never see the hippie types in the woods.

Birmingham, Alabama

I heartily approve of your study of the ecology movement. However, in my opinion your questions are difficult to answer. For example, my emotional reaction is somewhat different, in some cases, from my weighed reaction.

Flagstaff, Arizona

This questionnaire seems to be of a higher caliber than the usual stilted type. However, there are still a couple of questions like "When did you stop beating your wife?"

Yonkers, New York

I feel your questionnaire is much too limited in scope, and perhaps slanted to those who make a lot of noise but have never picked up a beer can. I feel that the "ecology movement," as you term it, has far greater significance than your surface treatment would indicate.

Bedford Hills, New York

Gerlach and Hine may be hell on wheels as anthropologists, but either their bias shows or they are lousy "objective question" developers. The questions have no place for a person who can see both sides of the question. The reader is assumed to be committed to all-out conservation or all-out despoliation.

I am afraid that the big emphasis on "ecology" (seldom has a word been more misused) will be followed by a letdown which will negate any gains won by the current

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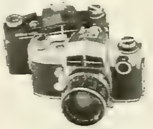

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"hard-sell." Too bad we cannot be moderate in all things.

My wife agrees with me, so I know I am right.

Grants Pass, Oregon

Thank you for putting out this questionnaire. It helped sort out some of my own thoughts on these matters!

Moraga, California

Saving the Cheetah

In the current issue of your excellent publication is a questionnaire relating to an anthropological study of the ecology movement, a subject which reaches me both as an anthropologist and a zookeeper. I wanted very much to submit this questionnaire, but was disturbed by the necessity, in doing so, of mutilating the delightful photograph of a female cheetah and young which accompanied Dr. Schaller's article beginning on the reverse side of the page. I elected to submit the completed form, but I will always regret the defacement of one of my copies of Natural History.

Houston, Texas

If you think that I'm going to cut up my issue of Natural History to answer your questionnaire, you are out of your gourds. (Besides, the cheetah on page thirty is already rare enough.)

Woodbridge, Connecticut

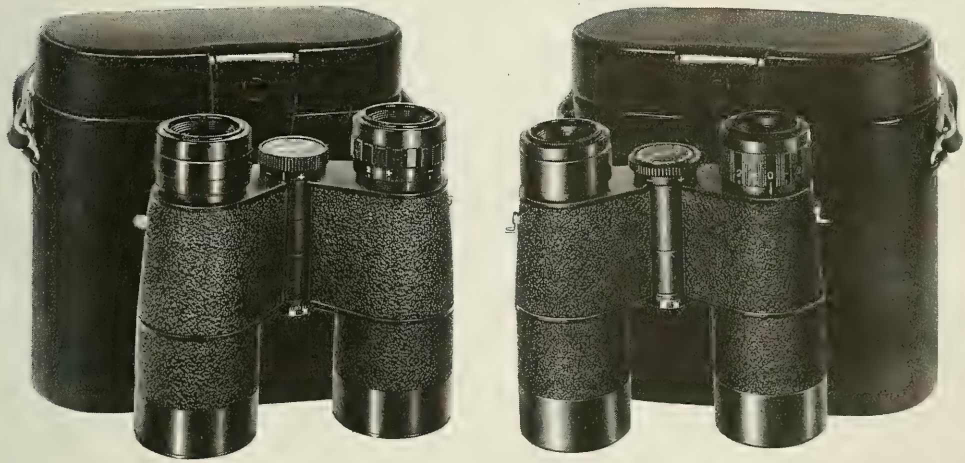
The printing of the questionnaire on the reverse side of an interesting article is a small example of the incompetence of so-called leaders that is so common in American society. This one factor is the greatest stumbling block to the solution of important ecology problems.

Jamaica, New York

My copies of our beautiful magazine pass along to one family after another until they eventually wear out or wind up in school to be shared as widely as possible. Imagine the consternation of my chain of readers at finding half a page torn out, half the photo of the critters on pages 30-31 denied them.

Not everybody has a machine handy to copy things and avoid mu-

feather weights



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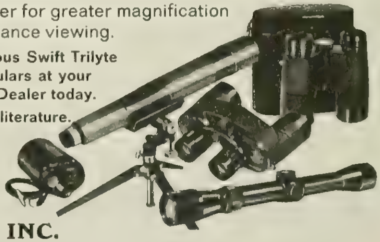

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It works because every time someone tosses in a coin, it helps Foster Child Ho Bau and his family. Bau's wishes may not be like your child's but they are just like those of thousands of children who are waiting for Foster Parents. They wish to enjoy childhood without the pain of hunger. Without the fear of sickness. Without the desperation of poverty.

Everyone who visits the Museum and Art Gallery in Reading and tosses his money in its wishing well is Bau's Foster Parent. They read his letters which the museum displays. He writes of his classmates in the fourth grade (where his favorite subject is composition), of his brothers and sisters, and of helping his mother work their small piece of land.

Through Foster Parents Plan's program you can bring help and hope to a child and his family. Your $16.00 monthly contribution provides them with a cash grant, medical care, counseling from social workers and household supplies.

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Make checks payable to Foster Parents Plan, Inc. All contributions are tax deductible. PLAN operates in Bolivia, Brazil, Colombia, Ecuador, Peru, Indonesia, Korea, the Philippines, and Viet Nam. PLAN is a non-political, non-profit, non-sectarian, independent organization, registered under No. VFA019 with the Advisory Comm. on Voluntary Foreign Aid of the Agency for Int'l. Development. NH-10-70

When someone somewhere cares, someone somewhere survives

tilation of originals. Why couldn't an insert such as the enclosure be used, instead of your method which forces most readers to commit mayhem?

If you have nobody around to stand guard against iniquities of this nature, I will be glad to serve as anti-atrocity editor for a retainer of 5¢ a year, paid in advance.

Mount Clemens, Michigan

An Old Story

I have been "conservation minded" for 25 years. Suddenly, it is popular! It would appear that persons with serious personality "fractures" have found another cause in ecology.

Lawrence, Kansas

The way we now feel about the environment is how we've always felt—the difference is that now other people don't think we're so nutty to want to have nice areas to sit and look at birds, etc.

San Diego, California

I've been an ecofreak for 30 years.

Winchester, New Hampshire

I have always lived close to nature and supported conservation. I would starve before living in a large urban center.

Nederland, Colorado

I am 82 years old and have passed the torch.

St. Louis, Missouri

What to Do?

A good number of us have been concerned at the decreases in bird, animal, and fish life in our Everglades and in our coastal waters. Some have been active in their protests, but the government keeps on doing what it wants—and conservation is ignored.

Please, if you can suggest an active way for us to participate in our environmental improvement and the whole ecology, I would appreciate hearing from you.

Palm Beach, Florida

He doesn't just sing. He broadcasts the weather.

When you hear the sound of the striped crested cuckoo on a South African nature trail, listen closely. He's a weather broadcaster.

If his song consists of descending notes, then the weather will be fine. But if it mounts, look out for rain.

For a different kind of forecasting, keep an eye out for the African hoopoe. When he appears, the Bantu know it's time for ploughing.

Another helpful bird is the honey guide. With his excitable chirp and directed flight, he leads humans and animals to hives of wild honey.

All this should tell you South Africa is particularly rich in bird life. If you can imagine the sound of a million birds awakening, then you will know what daybreak is like out in the bush.

There are over 100 game and nature reserves in South Africa, including bird sanctuaries, flower reserves, and immense tracts of land devoted to animal life.

At one reserve, there are no fewer than 300 species of birds to be seen. This includes an abundance of aquatic bird life, such as the fish eagle, dwarf goose, water dikkop, fishing owl, African jacana, and South Africa's national bird, the blue crane.

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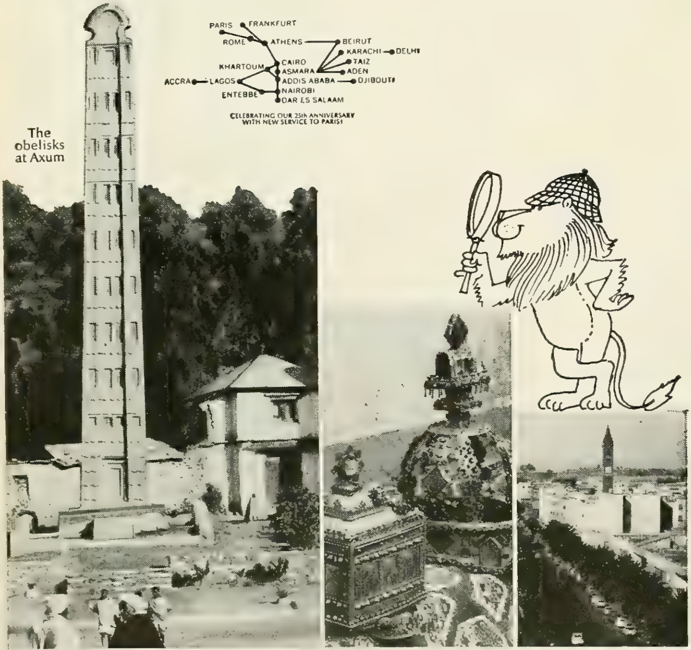

The obelisks at Axum

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I would like to know how I might be of assistance. What can I do? After all, I am a big, fat nothing as of now. I would like to contribute something worthwhile before I die.

Washington, D. C.

A Feeling of Hopelessness

I personally do not think the environment can be saved. Man, in my opinion, is too egocentric to pay the price in time; therefore, I'm about to switch from an active to a passive role.

El Paso, Texas

What's the use of trying? Ever try to stop strip mining?

West Liberty, West Virginia

The more I see incompetent young people refusing to learn the necessary hand skills, scholarly discipline, and historical and scientific knowledge, and resorting to foul-mouthed criticism as an all-purpose remedy, the more disheartened I am to see that my 30-year commitment to a cleaner, better, happier world was a hopeless dream. I wish I had spent my life indulging myself instead of working and studying and paying taxes.

Bloomington, Indiana

I have a sense life is over and although I fight, I really wait to die. Regressive selection has gone too far with man. We should have never gone beyond food gathering.

I use work as a drug. I farm part-time. I live on a personal basis. I belong to nothing.

Coopersburg, Pennsylvania

I personally believe it is time for man to leave the earth: he is more a destroyer than a builder.

Let earth renew itself.

Bronx, New York

I think it's making me neurotic.

Baltimore, Maryland

Ecoaction

I am no longer content to sit by and say "you can't do anything about it because everybody does

Continued on page 80

Most thru-the-lens meter systems average total scene brightness. They work fine for most normal pictures. But, in situations like this, an averaging system would be fooled by the bright background. Result: severe under-exposure for the main subject.

With a spot meter system, you'd probably take several readings and average them yourself. (A single reading of the wrong area would produce faulty exposure.) Dual systems, using both spot and averaging meters, not only inherit the problems of both, but also slow the photographer down because he has to make a choice.

Nikon beats the averages

with the Photomic FTN "center-weighted" meter system for Nikon F. It measures the brightness of the entire scene but gets 60% of its exposure information from just 1/7 of the picture area, outlined in the center of most Nikon F finder screens. From here, its sensitivity diminishes rapidly towards the screen edges.

In our example, the FTN will automatically compensate for the brightness difference between central subject and background. Here, as well as in normal situations, it provides correct exposure, with a single reading.

What's more, the FTN measures subject brightness on the finder screen, where the image is in focus. It permits wide-open readings with all Auto-Nikkor lenses as well as stop-down measurements, with non-automatic lenses and when bellows or extension tubes are used.

New features offered by the Photomic FTN include: automatic lens indexing, which eliminates need to adjust ASA/aperture alignment when interchanging lenses; shutter speed visible in finder; 2-second and 4-second exposure measurements where required, among others.

The Photomic FTN is interchangeable with all other Nikon F finder systems, except that earlier Nikon F bodies require some adaptation.

For details see your Nikon dealer, or write, Nikon Inc., Garden City. N.Y. 11530. Subsidiary of Ehrenreich Photo-Optical Industries, Inc. EPOI
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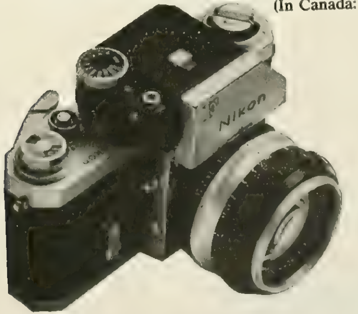

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A Naturalist at Large

The Cliché of the Killer

by Victor B. Scheffer

Along the shores of the Puget Sound of Washington, the Norwegian fishermen call the killer whale "spekkhoggeren," or fat-chopper. They see it in action. They watch it go rushing through a school of seals, porpoises, or fish, tearing out great chunks of meat, then circling to pick up the pieces. And when a fisherman has a chance to photograph a killer—perhaps one found dead on the beach or tangled in a net—he focuses on the teeth, the awful weapons of destruction, strong and yellow, evenly spaced, up to fifty in number. The photographer can be expected to stress this feature, which perpetuates the cliché of the killer whale as a vicious and bloodthirsty beast. The killer (*Orcinus orca*) has had a very bad press.

In the lore of the killer, two stories are often recounted as evidence of its fierceness. The first is that of Ponting, the photographer who traveled with Robert Scott to the Antarctic in 1911. Ponting was standing on an ice floe, camera in hand, waiting for a group of eight killers to reappear. Suddenly the animals rose beneath the ice, breaking it into bits and forcing him to dance from one bit to another to gain the safety of the shore.

"And not a moment too soon," he wrote. "As I looked back, a huge black and tawny head was pushed out of the water at the spot, and rested on the ice, looking round with its little pig-like eyes to see what had become of me. The brute opened his jaws wide, and I saw the terrible teeth which I had so narrowly escaped." Ponting came to no harm, and down to the present day there is no authentic record of a human attacked by a killer whale. Frightened, indeed, but not attacked.

The second story, Professor Eschricht's, was published in 1866. From the stomach of a stranded killer he recovered thirteen porpoises and fourteen seals; a fifteenth seal was stuck in the animal's throat. But reading his story with a critical eye, you find that this impressive meal was, in fact, only fragments representing food eaten over an uncertain period of time.

A more recent story is told by John Prescott, curator of Marineland of the Pacific, in southern California. Among the Channel Islands he saw a killer whale leap clear of the water while holding an adult male sea lion crosswise in its jaws. "The whale then played with the sea lion for about twenty minutes, sometimes throwing the carcass high into the air." No mean trick, when a bull sea lion may weigh 600 pounds!

Although today we know a great deal about the killer whale, we continue to marvel at what we learn. The largest of the dolphin family (up to nine tons), it can outswim any other marine mammal (up to thirty knots), and it lives in all the seas of the world to the limits of polar ice. In the course of evolution it has become a predator supreme. If you were to select a counterpart among the sea mammals to match the lion or the wolf, or any other large, active, pack-hunting animal of the land, the killer whale would uniquely be your choice. Among the eighty kinds of cetaceans, only the killer whale feeds extensively on warm-blooded prey.

The marine waters near my home

in the Pacific Northwest have become famous as the birthplace of the idea that the dread killer whale can be tamed. In captivity it proves to be docile, "friendly," articulate, and responsive to individual trainers whom it learns to identify. Having no enemies in the sea, it looks upon man without fear. We are just beginning to realize the value of the killer whale to entertainment, education, and research. And we are beginning to realize that certain ethical problems in the chase and capture of this magnificent creature will have to be solved. But more about this in a moment.

To the best of my knowledge, no killer whale has ever been taken alive and unharmed anywhere in the world outside the sheltered waters of Washington State and British Columbia. (A dying individual was once held in southern California for less than two days.) A biologist who studies whales for the United States government believes that in Puget Sound "the killer whale population is probably denser than anywhere else in the world," while two local whale hunters claim that "as many as 200 or more at a time may swim into this inland area of water."

New light on the killer whale can be dated precisely from July 16, 1964, when collectors from the Vancouver Public Aquarium fired a harpoon into a surprised young male near Saturna Island, British Columbia. They were after a fresh carcass to be used as a model for a museum replica. But the victim was only stunned, and in a flash of serendipity, the collectors decided to tow him alive to Vancouver, forty miles away. This they did, and

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ANSWERS TO ALL THE ABOVE QUESTIONS — plus an interesting variety of others — 39 in all — have been selected from recent issues of PASSPORT — **the monthly newsletter for the discriminating international traveler.** All are bound into an attractive 34-page "PRINT-OUT." This informative volume is yours together with a 6-month trial subscription to PASSPORT itself for only $20.00. These questions typify the kind of up-to-the-minute, hard-to-get, travel information you'll find in this intriguing, much talked about, monthly newsletter. Keeps you **way ahead** of the guidebooks. **Not a mass travel publication. Appeals only to independent or deluxe-class travelers.** Best resorts, hotels, restaurants, art, music, theatre, golf and other sports. For people of taste and discernment who want the best in world travel.

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ARTHUR MORRILL HALL
SCIENCE

QUESTAR KEEPS REPEATING ITSELF

We note that many schools and colleges start out with one Questar, and then as time goes by, repeat orders begin to come in, letting us know that a whole science class is being equipped so that each student will have his own telescope. To us this makes more sense than providing one big instrument for a large group. It permits a student to give his full time to observing instead of waiting his turn for a brief look. It would seem that the important question is — how many Questars will your budget allow rather than how large a telescope you can get.

This was the point of view at Southern Connecticut College, where Robert L. Brown is shown conducting a class engaged in solar observation. The Questars are equipped with totally safe sun filters which keep out all harmful rays.

This is the great thing about Questar — it does so many jobs that the instrument is never idle. Moon and planetary observation at night, sunspots in the daytime, or a trip into the field where it is used in nature studies, often to observe phenomena that would otherwise be inaccessible — this easily portable instrument makes it all possible. Also with Questar, students learn the art of high-power photography by taking pictures of all they observe. And however they use it, they learn to appreciate fine resolution.

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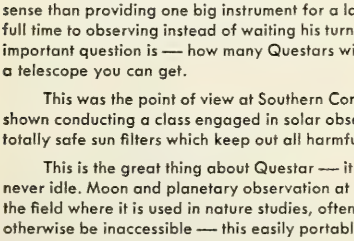

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there they kept him in a makeshif pen for eighty-seven days. Thousands of visitors came to see the world's first captive killer whale On a special radio program his voice was heard by millions across Canada, while the Canadian National Film Board released a movie about him in forty-four countries. The name Moby Doll, chosen in a radio contest, proved embarrassing to the aquarium staff when they finally learned his sex.

Public interest in killer whales was still running high when, six months after the death of Moby Doll, another killer was accidentally trapped behind a fishnet near the village of Namu, British Columbia. This was a big one, twenty-one and a half feet long, weighing 7,520 pounds. Seattle promoters purchased him for $8,000 and towed him to a pen on the Seattle waterfront. Here Namu, as he was called, became very tame and eventually allowed men to ride on his back. He lived for a year in the polluted waters at the edge of the city, then died of a bacterial infection.

The first killer whale deliberately chased and taken alive was the young female Shamu, who was surrounded in a purse seine near Puget Sound in 1965. She lived peaceably for several months in the pen with Namu, then achieved distinction as the first killer whale to fly. She was sent in a turboprop plane to Sea World, in San Diego, California.

Still there, Shamu has learned an amazing repertoire of tricks, one of which is to leap vertically to clear the water with the length of her graceful seventeen-foot body. Another trick is to open her jaws wide to admit the head of her trainer, who plays the role of doctor examining her tonsils.

Thirty to forty killer whales have been captured in the Pacific Northwest and held for sale or display since the summer Moby Doll made the headlines of the world. Reliable figures are hard to obtain, for the hunting of small whales and dolphins is unregulated in Washington State. In one spectacular catch in 1967 in Puget Sound, fifteen killers were netted; of these, seven were released, three died of injuries, and five were held for sale.

Continued on page 76

Don't die, Florida.

We need you.

You can be sure we'll all feel it if Florida plunges into ecological collapse. And that's what's about to happen to the Sunshine State. It's beginning to feel Nature's own backlash. A backlash strong enough to turn this citadel of tourism, beefsteaks, winter vegetables, and wealth into an environmental corpse.

The Sierra Club believes the crisis warrants a book. Now we have that book. It's called *Everglades.*

Everglades demonstrates how human blundering and plundering in South Florida can create economic havoc and ultimately affect the lives of Americans everywhere.

The problem isn't just the threat of a proposed super-jetport near Everglades National Park. It's people. People unaware of the fragility of this unique subtropical ecosystem. People who pick away at Florida's land and water resources with bulldozers, tree crushers, draglines, and DDT. People unintentionally destroying water, soil, vegetation, and wildlife through the misuse of technology.

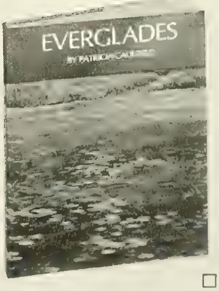
If we are to save the nation's only subtropical wilderness, then people must be made to understand all of the values at stake in South Florida. *Everglades*—the story that had to be told—is where each of us can begin.

The beauty of the region is preserved in sixty-five full color photographs by Patricia Caulfield. Her work reflects the dynamic life force of the Everglades: the snarling cougar, the implacable alligator, the soaring ibis, bursting red blossoms of saw grass, and turbulent thunderheads stacked like mountains against the sky. Complementing the photographs are selections from the writings of Peter Matthiessen, novelist and author of such works as *Wildlife in America* and *Under the Mountain Wall.* And there is a fact-packed essay in six chapters by John G. Mitchell, a former *Newsweek* science editor, now editor-in-chief of the Sierra Club.

Everglades is another in the Sierra Club's award-winning Exhibit Format Series—big books about big wild places that must never be allowed to grow tame.

Hopefully, *Everglades* will open enough eyes to help keep this one great wilderness untamed—and Florida alive and well. For as Florida goes (or Maine, or Ohio, or Utah), so goes the nation.

That's why we need Florida. That's why we believe *no* state should be allowed to write its own epitaph: *How to Secede From the Union Without Really Trying.*



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Georgia Granite

Amid scattered woodlands and rolling hills, islands of ancient bedrock foster an unusual collage of texture and color

by William A. Bake, Jr.

East of the Blue Ridge, where the land smooths into the southern piedmont and drops toward the fall line, ancient rocks shove upward. The skeletal land mass seemingly defies its inevitable disappearance beneath the Atlantic with one last shrug. Through the worn red clays—from the Carolinas to Georgia to Alabama—the rock swells and bubbles to the surface in gray masses of granite. Known locally as mountains, or flatrocks, the granite outcrops of the southern piedmont are a unique environment that has survived time and change.

At a distance, the granite appears drab and formless. But this is only an illusion; far from being formless, the rock, rounded by the ages, has an elemental simplicity. To sense the form, one must catch the nuances: the play of light across textured surfaces or the symmetry of water-carved pools. Weathering, here, has been a story of small persistences far antedating the sculptural forces seen on glaciated granites to the north and west. Walking the granite outcrops of the southeast, one sees their subtleties: the power of countless rainstorms and of plant decay, of a million little nothings gnawing at the rock and finally subduing it.

At closer range, the continual life process unfolds. Ice lies packed among the rocks or spills over a cliff into a tapestry of icicles. Gnarled pines and cedars thrust from cracks, gripping and splitting their way toward elusive water. Plants grow and decay, paving the way for more of their kind while struggling to produce enough soil to sustain them.

Time has been the essential catalyst in the evolution of this unique ecosystem. Despite the variation in age and structure of the granites of this region, they all extend from the earliest beginnings of life on earth—more than half a billion years ago. Although the date of their exposure to the surface remains unknown, the finely tuned ecology of these outcrops suggests that most of them were uncovered well into ancient geologic time. In a process that has the promise of being timeless, the exposures resist the erosive powers that will eventually level the piedmont. Soil that takes centuries to form can be washed away in one rainstorm, and vegetation that has needed years to colonize one flaw in the granite may be killed in a single drought. Occasionally, soil may cover an outcrop, but its triumph is an exception. The shallow, soil-filled bowls, or "weathering pits," that dot the outcrops attest to their extended absence of soil. Studies have shown these pits to be anywhere from 100,000 to a million years old. In the Yosemite Valley, where the granite is similar, weathering pits can be found only in areas that have escaped the glaciation that carved the valley.

Molded and matured by various plants, many of which are confined to the outcrops, the granite incorporates a complex flora. Of these, two are especially commanding. Early in March, shallow, soil-filled depressions in the rock seem to fill with a crimson broth as tiny *Diamorpha cymosa* begins to grow. Like many of its sister granite plants it bears no common name—a testimony, not to lack of beauty, but to the confined company it keeps. Found almost exclusively on the southern granite outcrops, it is an uncommon relative of the less vibrant rock cresses of the New World. By late spring it disappears, aging into miniature forests of red stalks and seed pods.

Diamorpha's association with the granite is no accident. Given ample time, natural dependencies develop. With no glaciers to scour them, the southern granite exposures became the exclusive domain of a score of plants, many of which are unlike even their

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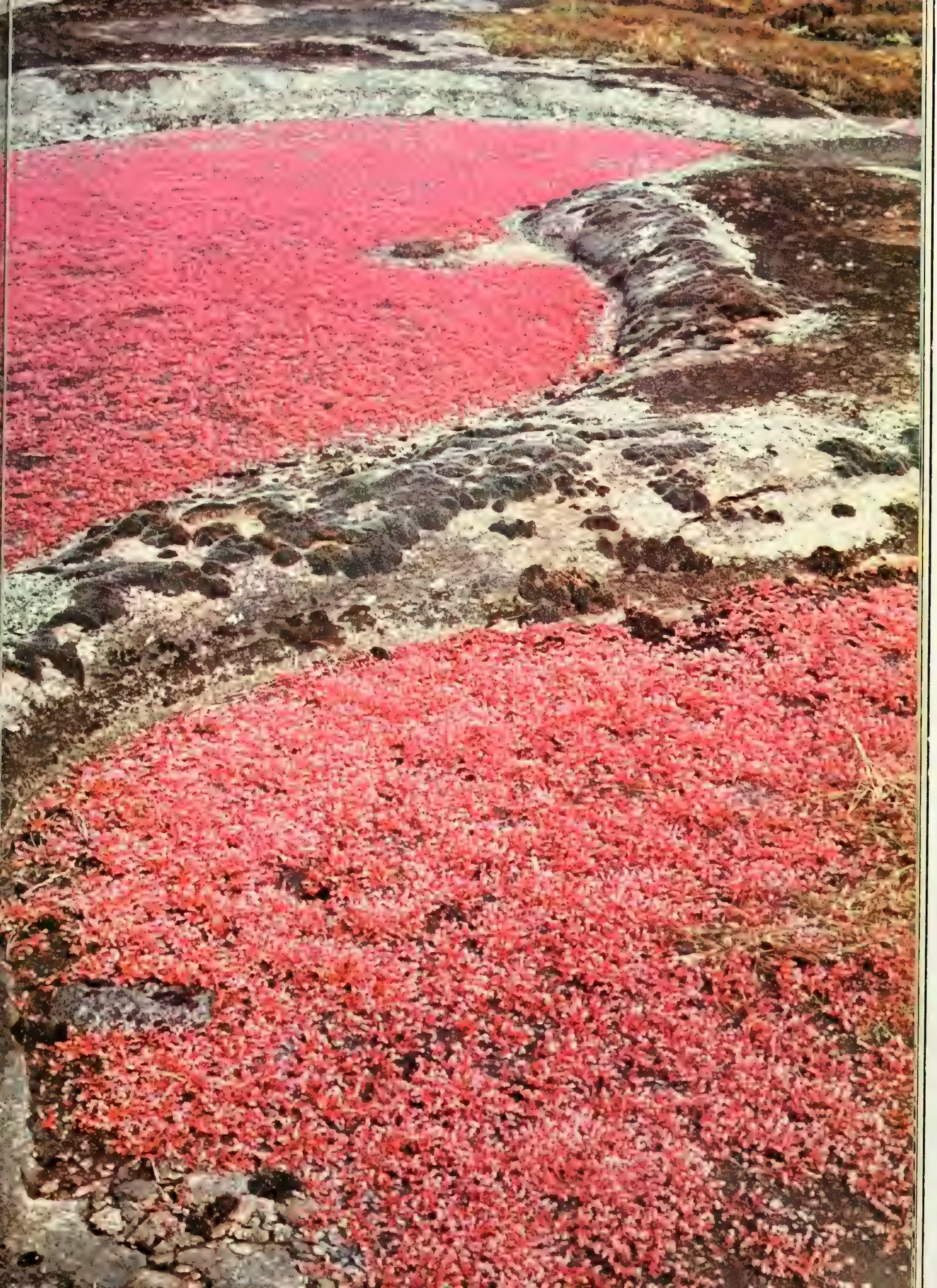
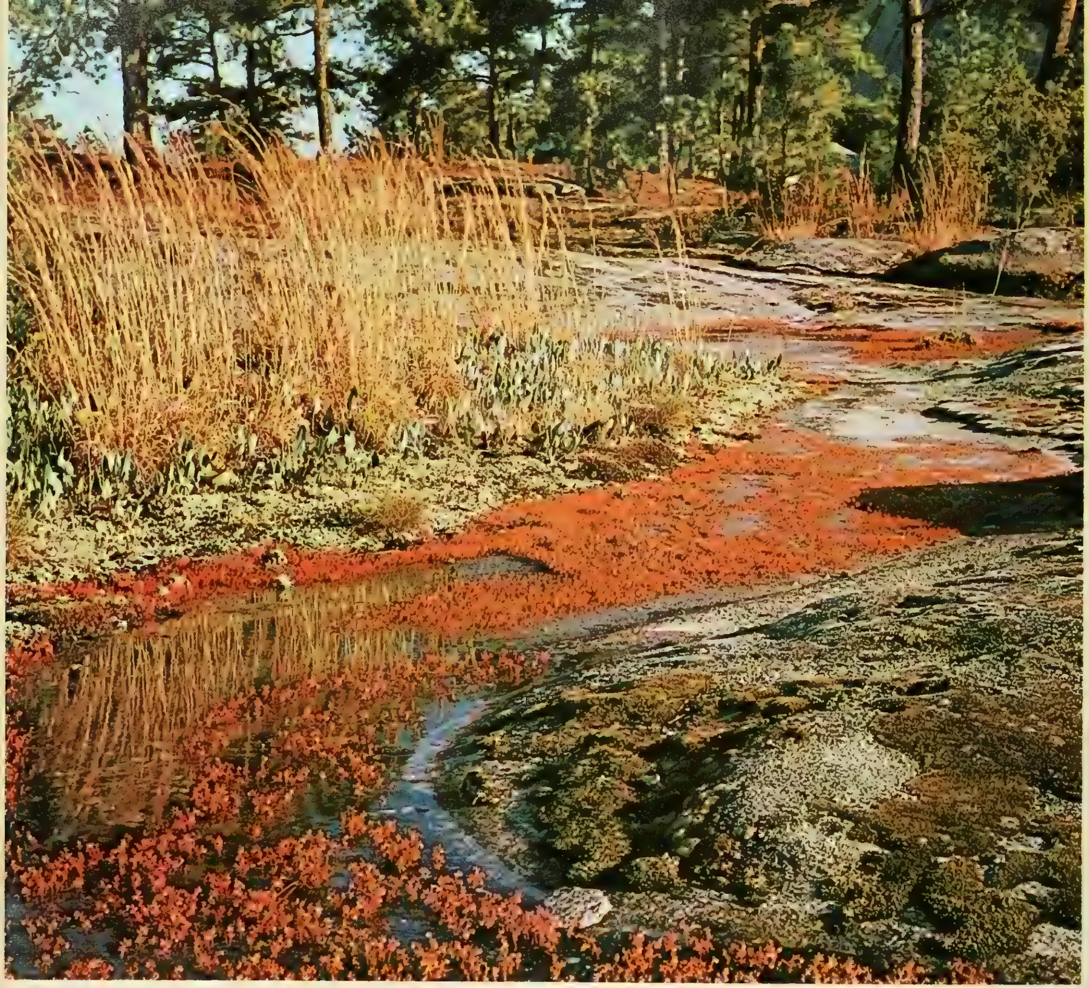
Diamorpha cymosa in full bloom covers Heggie's Rock near Augusta, Georgia. As with many granite plants, it bears no common name.





By late spring only the red stalks and seed pods of *Diamorpha cymosa* remain. Seeds of this plant, an annual survive the harsh climate.

Water cascades over a granite bed in the high shoals area of the Appalachee River.

Cedar and mosses are common
granite outcrops, but the sc
rock and water deter the creat
of a permanent soil lay

Lichen occupies a niche on a granite outcrop in the winter, when much of the rock is under ice. It also lives through the hot, dry summer.

The depth of a rounded "weathering pit" on Big Flat Rock near Veazy, Georgia, helps date the granite outcrop.

nearest relatives. Common to them all is the ability to survive harsh conditions. In January the rock may be sheathed with ice; by late summer it is parched by weeks without rain. The special savagery of the environment imbues the unique flora with the same immortality seen in the parent granite and, in turn, makes the outcrops areas of botanical curiosity unsurpassed in eastern North America.

Most of the granite plants remain scattered, hidden, and little noticed. Botanists and naturalists delight in them; others pass them by. One major exception is *Viguiera porteri*. On Stone Mountain, near Atlanta, Georgia, where the vistas are most expansive, these yellow, daisylike plants proliferate. Every square foot of soil, every flaw in the granite, hosts countless *Viguiera*. Like the granite itself, *Viguiera* is an imposter on the landscape. Near relatives of the flower are found no closer than the southwest and Mexico. An inhabitant of arid regions, its element is dry rock. Like *Diamorpha*, it survives the harsh environment as an annual, living only to produce seeds in a tenuous, yet durable, cycle.

In conjunction with the endemic botany of the granite outcrops there is a profusion of lichens and mosses. Rust orange, sun-scorched gray, spring green, the lichens flourish where little else can survive. With them, in dependence, exist carpets of thick velvety moss. Shimmering, emerald green when wet, or dormant and gray when dry, they cling to streamsides, fissures, low places—wherever water gives them life. These delicate mosses and lichens provide a lush counterpoint to the harsh rock.

Yet the granite is so unyielding that not even the soil-building power of the mosses and lichens has been of importance. As quickly as they are freed from the rock, weathering removes the grains of granite loosened by these pioneering plants. Only water and ice seem to impair the rock's endurance. Water causes an infinitesimal expansion of the rock, eventually leading to shallow seepage parallel to the surface. In time, in a process called exfoliation, the water and ice undermine the rock, forming numerous flat slabs. Like sloughs on some giant epidermis, these slabs lie scattered across the granite, casualties of a battle that the weathering process may never win.

In yet another sense, the granite exposures are counterpoints to the land. To a large extent, the ecology of these outcrops is segregated from that of the piedmont. In the humid southeast, complexity rules. A large number of species compete and thrive in undisturbed piedmont forests. On the granite, however, the rule is reversed. The rock is a great reducer, transforming the complexity of the surrounding forests into a well-ordered but relatively simple series of life systems, each dependent on its own tolerance.

A variety of abuses have long plagued the granite exposures. Several have already been destroyed by quarrying. Others face a similar fate. One of the most beautiful and undisturbed, Heggie's Rock near Augusta, Georgia, is currently owned by a gravel company, and its granite will probably be shredded and scattered across rural roads. In most areas local residents regard the outcrops as ideal dumps, and smashed bottles, cans, and car engines litter them. Still other areas have been substantially altered by grazing.

At present only two granite exposures, both in Georgia, are receiving protection. Panola Mountain is maintained as a natural area by the Georgia State Parks Department. Stone Mountain (1,686 feet)—the largest outcrop—receives minimal protection as a nationally known recreational area and bears the burden of a plague of trash and grafitti. While protection of one or two granite exposures may be infinitely better than nothing, it is indicative of the ecological tokenism prevalent today. Lacking an essential systems approach on a national scale, we have been satisfied to preserve only the remnants of our natural areas.

Perhaps the granite exposures of the southern piedmont will serve as reminders. At once interrelated yet uniquely independent, their individual existence remains important to their continued survival. Destruction of any one may eventually affect another. As we are slowly learning, there are no free-fire zones in nature. In another sense, these granite islands relate to man's larger island. In their time-carved uniqueness and perfection, they offer, in microscosmic perspective, a glimpse of the interrelatedness and complexity of all life systems.

onfederate daisies (*Viguiera porteri*)
roliferate on the granite slopes of
one Mountain near Atlanta, Georgia.

Sky Reporter

Astronomy at Phoenix House "Do you think people are nuts to believe in flying saucers or life in other solar systems?"

"Is the moon dead, or could there be life under the surface?"

"Is astronomy hooked up with astrology and horoscopes?"

The questions came faster and faster from the audience, a mix of teen-agers and adults, blacks and whites, men and women. The speaker, Robert Galandak of the American Museum-Hayden Planetarium, gestured mightily as he tried to explain trigonometry and nuclear fusion without a chalkboard. The air in the cellar of the renovated Brooklyn tenement was warm and stale, thick with cigarette smoke.

Members of the audience had one thing in common: they were all ex-drug addicts. Many had been in prison for crimes ranging up to manslaughter. Some had shaved heads or wore stocking caps to show their guilt for transgressions against their peers. They were attending a regular afternoon educational session in Phoenix House, on Prospect Place in the Park Slope section of Brooklyn, one of 15 such houses in New York run for, and by, ex-addicts.

Galandak became involved nearly two years ago when he picked up the telephone in his office at the planetarium and a voice said: "Hello. My name is Jerry ————, and I'm a drug addict. I want you to come and talk to us." Startled, Galandak listened further, and shortly thereafter gave his first lecture at the original Phoenix House.

Since then Galandak has spoken more than 30 times at Phoenix Houses in Manhattan, the Bronx, Queens, and Brooklyn. For subsequent visits to a given group, he prepares a structured presentation, complete with slides. But on an initial visit, he simply throws the floor open to questions. The approach worked well at Park Slope.

Easily fielding the questions, which he says are pretty much the same wherever he goes, Galandak tried to introduce critical thinking as he went along. Discussing life on other worlds (which he feels sure must exist elsewhere in the universe), he first led the discussion into a definition of life. Discussing astrology, he got into superstition and man's fear of the unknown—and into trouble, as well.

He noted that many parents use fear of the unknown to discipline children: they are told to be good or the bogeyman will get them. He asked the audience whether anyone had actually seen a bogeyman; amid explosive laughter, at least half nodded that they had.

Informal talks like Galandak's are not the only educational program at the Phoenix Houses. The average age of those now coming into the program today is twelve or thirteen (currently the youngest is an eight-year-old who was both using and selling heroin), and regular schooling by licensed teachers is important. In September each of the Phoenix Houses became a part of the city school system, right down to a P.S. number. If plans being made by Galandak and the education chairman of each Phoenix House work out, astronomy will be part of the curriculum.

On the Compressional Velocity of Provolone One of the innumerable problems perplexing scientists in the wake of the lunar voyages concerns the extremely low velocities at which compressional waves move through moon rocks. Compressional waves are a sort of sound wave moving through solid matter; the most familiar example are the waves that travel through the earth after an earthquake (*see* "Earthquakes," December, 1969). Such waves pass through surface rocks on the earth at velocities of four miles a second or faster; similar waves going through moon rocks are slowed to about a mile a second.

The difference was discovered when men created their own quakes on the moon (by crashing lunar modules on the moon's surface) and then read the results from seismometers left there by the astronauts. Most of the moon rang like a low-pitched bell for a long time—up to 50 minutes. But the signal lasted only a short time in the surface material, moving slowly and quickly losing strength.

Two geophysicists at Columbia University's Lamont-Doherty Geological Observatory experimented with compressional waves on two samples of moon rock and on a variety of terrestrial substances. The two men, Edward Schreiber and Orson L. Anderson, reported their findings in *Science*. In their words:

"To account for this very low velocity, we decided to consider materials other than those listed initially . . . . The search was aided by considerations of much earlier speculations concerning the nature of the moon, and a significant group of materials was found which have velocities that cluster about those actually observed for lunar rocks.

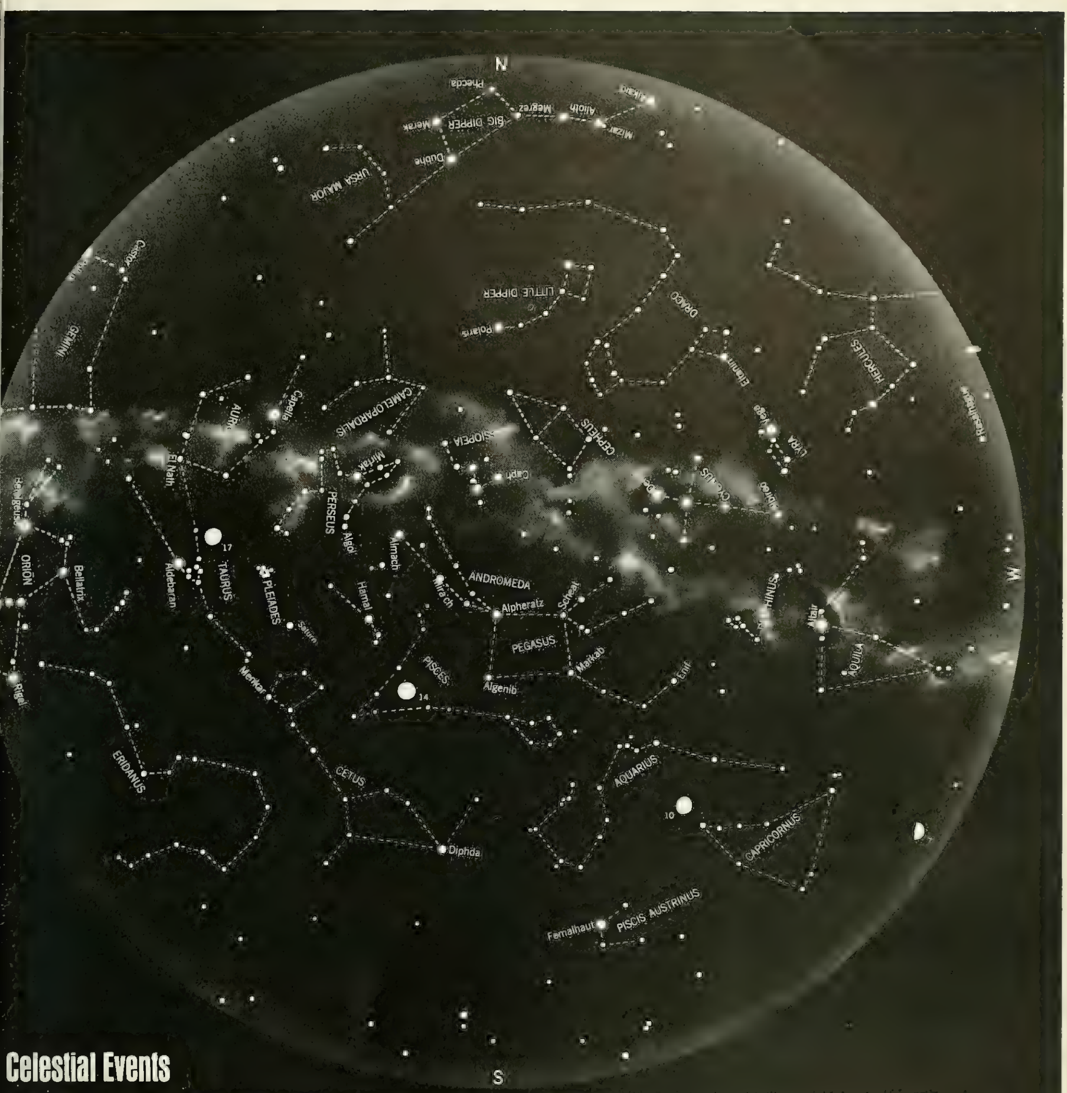
"These materials are summarized in [the table] . . . . The materials were chosen so as to represent a broad geographic distribution in order to preclude any bias that might be introduced by regional sampling. It is seen that these materials exhibit compressional velocities that are in consonance with those measured for the lunar rocks—which leads us to suspect that perhaps old hypotheses are best, after all, and should not be lightly discarded."

Most of the authors' table listed, for comparison, the compressional velocities of various rocks and minerals found on earth. The most interesting portion, reproduced below with kilometers converted to miles, compared lunar rocks and a variety of cheeses.

Compressional velocities of lunar rocks and earth cheeses

Material tested	Velocity (miles per second)	Material tested	Velocity (miles per second)
Sapsego (Swiss)	1.21	Cheddar (Vermont)	1.07
Lunar rock 10017	1.14	Emmenthal (Swiss)	1.02
Gjetost (Norway)	1.13	Muenster (Wisconsin)	0.97
Provolone (Italy)	1.09	Lunar rock 10046	0.78

JOHN P. WILEY, JR.


N
Phecda
Merak
BIG DIPPER
Megrez
Alioth
Alkaid
Mizar
Dubhe
URSA MAJOR
Castor
LITTLE DIPPER
Polaris
DRACO
HERCULES
GEMINI
Capella
AURIGA
CAMELOPARDALIS
CASSIOPEIA
CEPHEUS
Vega
LYRA
El Nath
Mirfak
Caph
Deneb
CYGNUS
PERSEUS
Algol
Almach
ANDROMEDA
17
TAURUS
PLEIADES
ORION
Bellatrix
Aldebaran
Hamal
Mirach
Alpheratz
Scheat
DELPHINUS
Altair
W
PEGASUS
Markab
AQUILA
Saturn
PISCES
Algenib
Enif
Menkar
Rigel
14
ERIDANUS
CETUS
AQUARIUS
10
CAPRICORNUS
Diphda
Fomalhaut
PISCIS AUSTRINUS
S

Celestial Events

The moon becomes full on October 14, then moves into the morning sky. Last-quarter occurs on the 21st, and new moon on the 30th. In November, first-quarter moon is on the 6th, full moon on the 13th.

Among the planets, only Saturn is in good position to be seen in October and early November. Rising about an hour after the sun sets and remaining visible all night, the planet is moving westward into Aries. Venus and Jupiter are evening stars, very low in the southwest at sunset, and become morning stars in early November. Mercury and Mars are morning stars.

October 16: Saturn rises below the moon tonight and the two move up the sky together.

October 20: Venus becomes stationary and begins to move westward, taking it closer to the sun.

October 21: Maximum of the Orionid meteor shower occurs, but a rising last-quarter moon will brighten the sky after midnight.

October 27: Mercury is in superior conjunction with the sun and now enters the evening sky. Look for Mars, a dim, reddish star, to the left and above the rising crescent moon this morning.

November 5: The Taurid meteor shower reaches maximum with dark, moonless morning skies.

November 9: Jupiter enters the morning sky.

November 10: Venus passes between sun and earth and enters the morning sky.

November 11: Saturn is at opposition from the sun. The planet now rises at sunset, sets at sunrise.

THOMAS D. NICHOLSON

★Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky. The map is for 10:05 P.M. on October 15; 9:20 P.M. on October 31; and 8:20 P.M. on November 15; but it may be used for about an hour before and after those times.

Peoples of INDOCHINA

The war-worn human fabric of Southeast Asia has survived many strains

by Charles F. Keyes

The small community of Mae Sariang, a district seat on the Burmese border in northwestern Thailand where I did anthropological field work, is a microcosm of the cultural complexity of Southeast Asia. In the market, one shopkeeper is from Yunnan; the father of another came from Fukien in southeastern China. Across the street are the shops of several Indian Muslims, and in a nearby drugstore the Burmese owner compounds folk medicines from prescriptions written on a palm leaf manuscript. On another street, shopkeepers identified as Thai speak languages distinctively different from the one used by the Thai of Bangkok. Some of these Thai in Mae Sariang are Shan from Burma; but the majority are Yuan, the Thai-speaking group that predominates in northern Thailand. Central Thai, or Siamese, are found only in government offices.

The different architectural styles and rituals of the Buddhist temples emphasize the variant forms of Buddhism in Mae Sariang. Most monks and congregations of Mae Sariang follow Yuan customs. In two temples, Burmese forms are followed, and in another two, the practices are Shan in origin. In the main temple, periodic services follow the forms of Siamese Buddhism.

elief at Banteay Srei
emple, Angkor, Cambodia

Secluded behind the market in Mae Sariang is a small mosque where both Indian and Chinese Muslims worship. A few Chinese also maintain Confucian customs in their homes. Five different Christian missionary groups, four Protestant and one Catholic, have representatives in Mae Sariang, all living in compounds on the outskirts of the community.

In the Mae Sariang district, as in all of Southeast Asia, a marked correlation exists between the ecological adaptations and the cultural traditions of ethnic groups who live in different parts of the district. Most of the people living in the town of Mae Sariang and the surrounding villages in the valley practice wet-rice cultivation and follow the major cultural traditions, especially Buddhism. The people in the hills flanking the valley are ethnically quite different from the lowlanders. They live primarily through the cultivation of dry rice by the slash-and-burn technique of agriculture. These hill dwellers, or tribal peoples, follow mainly animistic religions. Some are recent converts to Christianity.

Each tribal group in Mae Sariang has a distinctive background. One, the Lawa, is somewhat comparable to the American Indians in that their ancestors preceded the Thai in this area. Another group, the Karen, began migrating into the Mae Sariang region some 200 years ago. The Miao are the most recent migrants to Mae Sariang, having established themselves only about five years ago. The Miao have brought their most famous occupation—the cultivation of opium poppies—with them.

As a border community, Mae Sariang has felt many of the major political changes that have occurred throughout Southeast Asia. In the thirteenth century it became part of a Yuan kingdom. Between the sixteenth and eighteenth centuries, Mae Sariang, like the rest of northern Thailand, was part of the Burmese empire, which extended into parts of Laos and China. During a series of wars involving the Burmese, Yuan, and Siamese at the end of the eighteenth century, Mae Sariang lay directly on the route of invading armies. At the end of the nineteenth century, Mae Sariang, along with the rest of northern Thailand, was integrated into the kingdom of Thailand.

Although Mae Sariang district numbers only about 40,000 inhabitants, it has all the problems of ethnic and cultural heterogeneity that plague many American cities. Animosities and misunderstandings exist between lowlanders and hill people; between Buddhists and Christians; between old, established tribal people and new migrants; and between the numerically dominant Yuan and the politically dominant Siamese.

Mai Sariang resembles all of

Southeast Asia in the constant shifting of its ethnic composition, in the changing political status, and especially in the problems of ethnic and cultural conflict. An understanding of all these themes is important for any comprehension of the Indochinese conflict in which the United States has been embroiled for nearly a decade.

The three major traditional civilizations of the region—the Khmer (or Cambodian), the Siamese (ancestors of the populace of central Thailand), and the Vietnamese—were based in regions where large populations could engage in wet-rice cultivation. The Khmer built their civilization on the Cambodian plain, which could be irrigated by the waters of the Tonle Sap, or Great Lake, and the Mekong River. The original homeland of Vietnamese civilization was in the valley and delta of the Red River of Tonkin in North Vietnam. Siamese civilization developed in the central plain of Thailand, which is dominated by the Chao Phraya River. These three natural regions, together with that of the Mekong Delta, still comprise the cores of the major states of the area.

While the densely populated valleys, plains, and deltas were occupied primarily by single ethnic groups, the thinly settled highlands of Indochina have long supported a large variety of different groups. The people who live in the hills flanking the valleys of northern Thailand, in the uplands of North Tonkin and Laos, in the Annamese Cordillera, which lies astraddle the frontiers of Laos, Cambodia, and Vietnam, and in some of the lesser hill regions all practice a type of slash-and-burn agriculture. Also the upland people do not follow the historic religions found in the lowlands. Beyond these two broad similarities the upland people follow a vast range of cultural traditions.

In the centuries just prior to the Christian Era, people of three different language families occupied the Indochinese area. Mon-Khmer-speaking groups lived in Thailand, Laos, Cambodia, and the Mekong Delta region of Vietnam. Along the coast of central Vietnam and in the hill areas west of the coast, the populace spoke Malayo-Polynesian languages. Finally, speakers of Vietnamese languages populated the Red River Delta.

The impact of the civilizations of China and India upon the indigenous lowland cultures of Southeast Asia has led to both similarities and contrasts between the various Indochinese ethnic groups. Population shifts, including the immigration of groups into the region, also have contributed to the cultural differences.

During the first millennium of the Christian Era, a number of Southeast Asian cultures borrowed Indian ideas and amalgamated them with indigenous customs to form new civilizations. The Cambodians, or Khmers, established one of the most significant of the Indianized states in Southeast Asia. Khmer civilization found its ultimate expression in the elaborate monuments erected at Angkor near the Great Lake in Cambodia. Each of the monuments was an architectural embodiment of the concepts of the state cult of the god-king. From the tenth to the fifteenth centuries the god-kings of Angkor made the Khmer empire the dominant political power in the region.

The first major challenge to the Khmer empire was posed by another Indianized kingdom, the Chams, a Malayo-Polynesian-speaking people living in central Vietnam who advanced into the Khmer empire. However, they were forced to return to their homeland to repel attacks made by their northern neighbors, the Vietnamese.

The ancestors of the present-day Vietnamese first appear in history in the second century B.C. when their country, the Red River Delta region, was incorporated into the Chinese kingdom. After gaining their independence in the tenth century, the Vietnamese rulers promoted, rather than halted, the process of Sinification. To this day the Vietnamese display a Chinese tradition, developed during more than a millennium under Chinese rule, that stands in marked contrast to the rest of Southeast Asia.

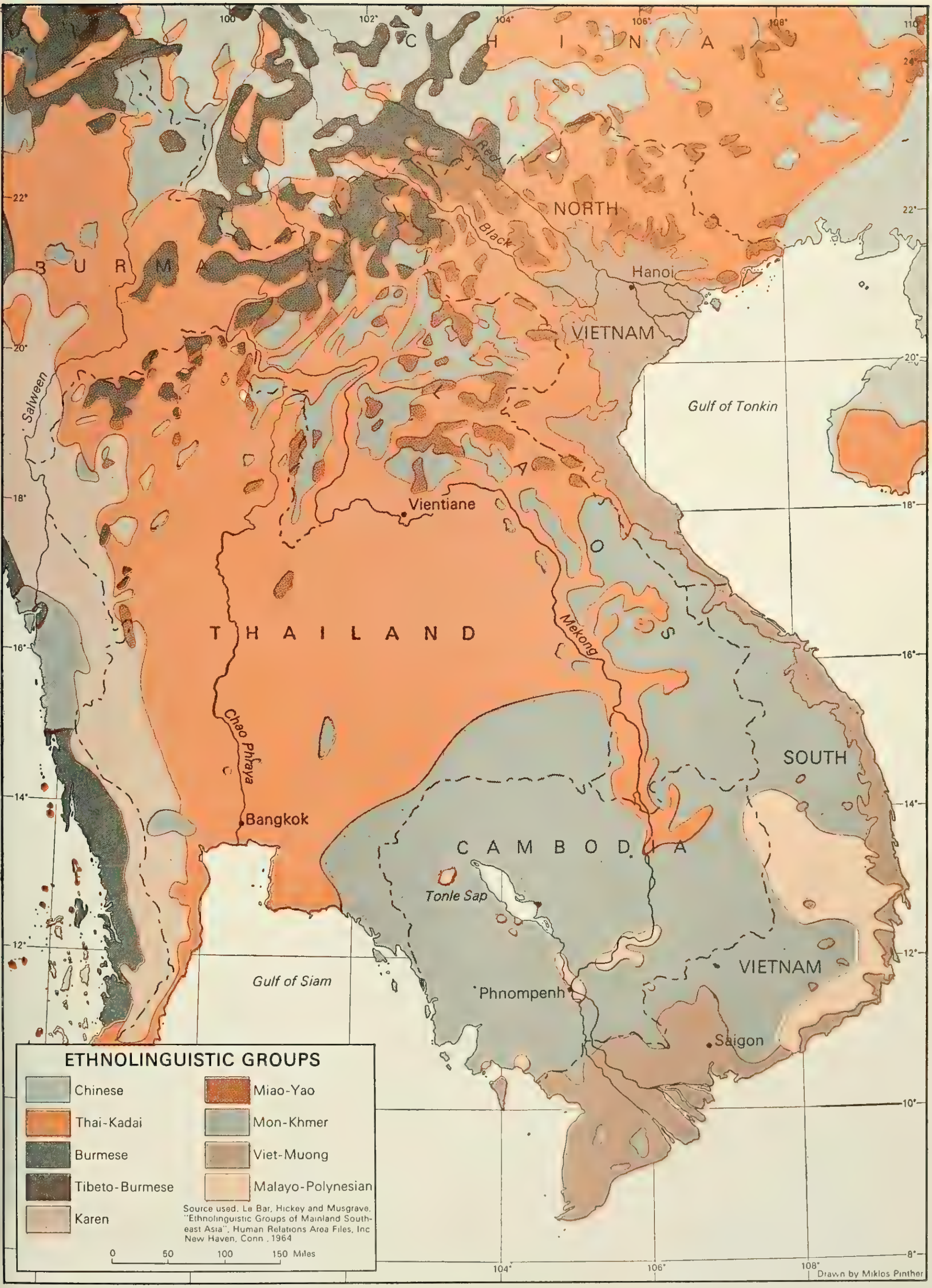
With independence, the Vietnamese began to expand. Because the highlands to the west were ill-suited to their wet-rice cultivation, they expanded almost exclusively toward the south. At first, they acquired coastal territories under Cham rule. By the end of the fifteenth century, the Vietnamese "push to the south" and periodic attacks from the west by the Khmer led to the collapse of the state of Champa in central Vietnam.

After the collapse of Champa, the Vietnamese continued to expand into the Mekong Delta region, which had formerly been part of the Khmer empire and which contained sizable Khmer populations. In the eighteenth century, these Mekong territories were formally annexed by the Vietnamese. From the late seventeenth century on, the Vietnamese also began to challenge the Siamese influence over the Khmer court in Cambodia.

The expansion of the Thai-speaking peoples into Southeast Asia parallels in some ways the Vietnamese push to the south. From their homeland in southeastern China, Thai-speaking people spread southward sometime before the eleventh century. By the beginning of the thirteenth century a number of Thai colonies had organized into petty states on the northern periphery of the Khmer empire. Other Thai colonies within the empire were ruled by Khmer governors. A number of these Thai colonies converted to Therevada Buddhism.

The combination of Thai sociopolitical organization with Therevada Buddhism brought the elite closer to the masses and led to the emergence, in the thirteenth and fourteenth centuries, of a new political force in Southeast Asia. After a successful revolt against a Khmer overlord by Thai chiefs, they founded states in north-central Thailand that eventually evolved into the powerful kingdom of Thailand (Siam), with its capital at Bangkok.

While the Siamese were estab-


CHINA
BURMA
THAILAND
LAOS
CAMBODIA
NORTH VIETNAM
SOUTH VIETNAM
Gulf of Tonkin
Gulf of Siam
Red
Black
Salween
Mekong
Chao Phraya
Tonle Sap
Hanoi
Vientiane
Bangkok
Phnompenh
Saigon
100°
102°
104°
106°
108°
110°
24°
22°
20°
18°
16°
14°
12°
10°
8°
ETHNOLINGUISTIC GROUPS
Chinese
Thai-Kadai
Burmese
Tibeto-Burmese
Karen
Miao-Yao
Mon-Khmer
Viet-Muong
Malayo-Polynesian
0
50
100
150 Miles
Drawn by Miklos Pinther

Source used. Le Bar, Hickey and Musgrave, "Ethnolinguistic Groups of Mainland Southeast Asia", Human Relations Area Files, Inc New Haven, Conn., 1964 lishing themselves in the Chao Phraya Basin in central Thailand, another group of Thai established themselves in the middle Mekong Valley. These people, who later became known as the Lao. formed the state of Lan Chang, which emerged in the middle of the fourteenth century. In the thirteenth century yet another Thai group in northern Thailand, the Yuan, founded the kingdom of Lannathai.

Both Lan Chang and Siam developed at the expense of the Khmer empire. By the middle of the fifteenth century, the Khmer empire ceased to exist, a consequence of internal weaknesses and external attacks by the Siamese. Cambodia, the successor kingdom to the Khmer empire, built its capital at Phnompenh, which was more defensible against Siamese attack than the Khmer capital of Angkor. For all their animosities, the Siamese and Khmer exchanged many cultural traits and today have similar cultural traditions. The Siamese took over many of the Indian concepts of statecraft that had been employed at Angkor, while the Khmer adopted the Siamese form of Therevada Buddhism.

While Cambodia was nominally a tributary of Siam for most of the period between the fifteenth and eighteenth centuries, Siam interfered little in the internal affairs of Cambodia and made no new claims upon Cambodian territories.

Early in the eighteenth century, the old Lao kingdom of Lan Chang broke up into the three small states of Luang Prabang, Vientiane, and Champassak. Siam, which was under attack by the Burmese, did not take advantage of the Lao weakness until the next century. By 1827, Siam had reduced Champassak to a Siamese province, totally destroyed the kingdom of Vientiane, and forced Luang Prabang to become a vassal state. Moreover, Siam also moved large numbers of people from the Lao states across the Mekong and settled them in northeastern Thailand. Today there are eight to ten times more Lao in northeastern Thailand than in Laos.

Siam also attempted to extend her influence eastward, beyond the Lao states and into western Tonkin. While the people of this area were primarily Thai-speakers, the Vietnamese had long considered the region to be within their orbit.

With the emergence early in the nineteenth century of two strong dynasties—in Vietnam and Siam—a clash between these two powers seemed inevitable. Both Cambodian and Lao areas were sources of conflict.

During the first half of the nineteenth century, the Siamese and Vietnamese directly confronted one another over both Cambodia and the Thai areas northeast of the Lao states. Open conflict broke out on two occasions. On the eve of the French arrival in 1858 the disputed principalities were tributary to both Vietnam and Siam, although Siam dominated Cambodia and the Vietnamese dominated the Thai area.

The French intervention caused a redrawing of the borders between the states of Southeast Asia. The French fixed the borders between Cambodia and Vietnam and forced Siam to renounce her suzerainty over Cambodia and cede back the northern and eastern provinces, which had been taken during the nineteenth century. The French created Laos out of several different territories lying mainly to the east of the Mekong. The Siamese were forced to renounce suzerainty over Luang Prabang and to give up the trans-Mekong provinces that had once been part of the kingdoms of Vientiane and Champassak. The border between Tonkin and Laos was also fixed.

These French actions have been viewed as having preserved Khmer and Lao independence from the Vietnamese and Siamese. However, this conclusion is open to serious question. The French justified their expansion into Laos and Cambodia with reference to traditional Vietnamese claims over these areas. In other words, the creation of French Indochina laid a mortgage against the futures of Laos and Cambodia, for Indochina was defined as that part of Southeast Asia that lay within the Vietnamese sphere of influence.

The French further complicated the picture by dividing Vietnam into three separate entities: the colony of Cochin China in the south, the protectorate of Annam in the center, and the protectorate of Tonkin in northern Vietnam. This dismemberment of Vietnam had some historical and cultural justification. Prior to the nineteenth century, Vietnam had been so divided. Moreover, the southern Vietnamese had somewhat different characteristics from the northerners because of more intensive contact with Indianized peoples and greater distance from Chinese influences. However, by refusing to recognize the unity that had been achieved during the first part of the nineteenth century by the Nguyen dynasty, the French created conditions that exacerbated the problems faced by the Vietnamese people today.

Other effects of French rule contributed to the cultural complexity of the region. In their administration of the tribal areas, especially in the Annamese Cordillera and in the uplands of Tonkin, the French chose not to work through the Vietnamese, thus widening the gap between the tribal peoples and the Vietnamese. French rule also undermined the traditional cultural bases of Vietnamese society, thus laying the groundwork for the appearance of new cultural forms. Many Vietnamese looked to other sources for cultural leadership. A significant proportion accepted Catholicism, which was spread by missionaries. Others joined new sectarian movements such as the

A Yuan woman in the Mae Sariang district of Thailand harvests a wet-rice crop. The lowland cultures throughout Indochina cultivate this grain.

Thailan

Thailand

Thailand

Thailand

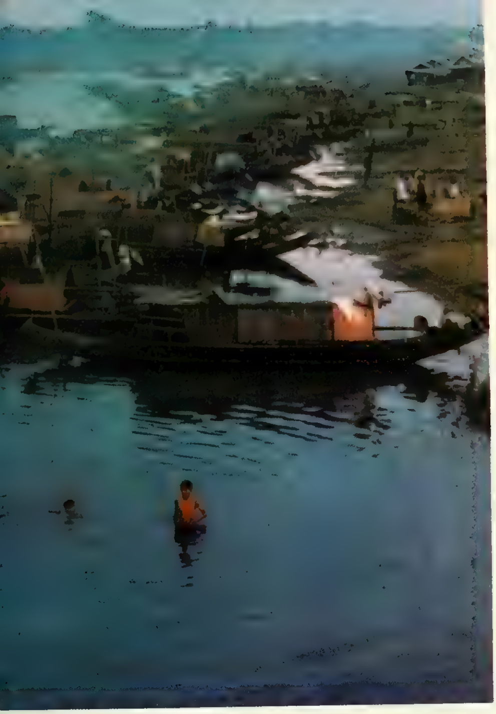
Cambodia

In the lowlands along major rivers and on the large deltas in Indochina, large, homogeneous cultures have developed, based on the control of water for rice cultivation. Animal and hand labor perform most jobs, including the dragging of teak logs from the jungle by elephants, the harrowing of rice paddies with water buffaloes, irrigation using primitive buckets held on tripods, and the threshing of grain.
At left, Karen women prepare a meal of small frogs — a good source of protein.

Cambodia

Saigon, South Vietnam

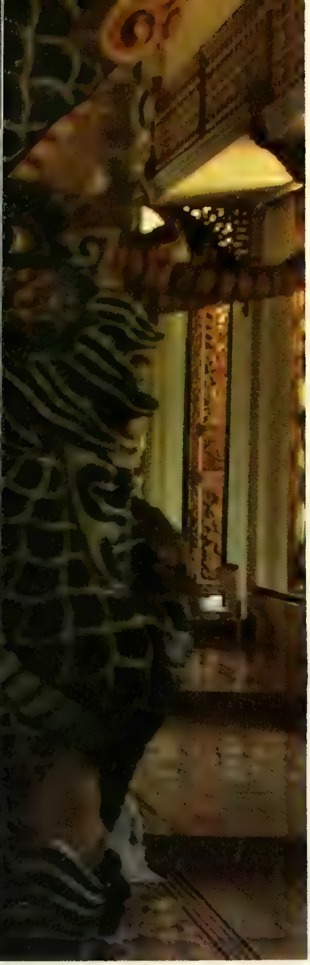
Northern Thailand



With the growth of national economies throughout Indochina since the colonial period, the population in urban areas has grown rapidly. Chinese immigrants often dominate the commercial sectors of the cities. Attracted by the variety of goods and the opportunity to sell homemade wares, many women from surrounding tribal areas go to the cities to trade. Housing is a problem in many cities, and although houseboats are common, living conditions on the boats are crowded and sanitation is poor.

igon, South Vietnam

Almost all of the major religious traditions are represented in Southeast Asia. The largest proportion of the people practice either Therevada Buddhism, Islam, or the amalgam of Confucianism, Taoism, and Mahayana Buddhism developed by the Chinese. There are many Christian communities. Hinduism, once a major tradition in the region, has left its imprint. And several million people follow a host of animistic traditions. Cao Daism, a hybrid of Buddhism and Daoism, is practiced in the temple above. The turret of the Buddhist temple, top right, reveals a Chinese influence. The reclining Buddha and seated statues represent Therevada Buddhism. Catholic girls, right, celebrate their first communion.



South Vietnam

Thailand

Bangkok, Thailand

Thailand

Saigon, South Vietnam

uong tribesmen watch as others rgain at a North Vietnamese rket. Creation of autonomous bal zones in this country s minimized internal conflicts.

Cao Dai and Hoa Hao. Yet others were attracted by a resurgent Buddhist movement. The Communist movement also provided a new cultural tradition for a large sector of the population.

For the Vietnamese, French rule led to a radical break with the past, but it did not have the same effect in Cambodia and Laos. These two countries were preserved almost as cultural museums. The French did little to interfere with traditional cultural institutions and little to improve the educational and economic systems.

While the French were contributing to the problems of ethnic and cultural complexity in Indochina, the Siamese were making advances in overcoming cultural parochialism in the territories under their rule. In a series of reforms at the end of the nineteenth century, the Siamese sovereign brought under a central administration the core area of metropolitan Siam in central Thailand, the Yuan areas of northern Thailand, the Lao areas of the northeast, and some of the Malay areas in the south. This process of integration was so effective that both Yuan and Lao were able to join with the Siamese in a common identity as Thai. The success of the Siamese king in molding what was to become the nation of Thailand greatly enhanced its ability to meet the challenge of Western expansion in the region. Of all the Southeast Asian states, only Thailand remained independent during the colonial period.

The colonial period brought another change in the cultural mosaic of Southeast Asia. The majority of the forebears of the Chinese and Indians now living in the region came during the colonial era. They were attracted by the opportunities created by the expanding economy of the Southeast Asian area.

Chinese migrants, coming mainly from the poverty-stricken rural areas of southeastern China, settled in significant numbers throughout Southeast Asia. Most of the Chinese who migrated to Vietnam settled in the south. The south afforded greater economic opportunities because the French spent more of their energies and resources in developing this region than the north. Small numbers of Chinese migrated to Cambodia and even fewer to Laos because the economies of these countries did not expand greatly during French rule. Thailand, although not under colonial rule, underwent a radical economic change in response to the Western impact. Her expanding economy drew more Chinese migrants than any other country in Indochina.

The Chinese in all of these countries assumed a dominant role in the commercial sector. All the societies of Southeast Asia have perceived this control of a sector of the economy by aliens as threatening.

The colonial rulers fostered policies that perpetuated the alien status of the Chinese. In Thailand, however, the Chinese had to accommodate themselves to an indigenous elite. Partially for this reason, Thailand has had the highest assimilation rate of Chinese of any Southeast Asian country. Still, the Chinese remain one of the biggest minority problems for Thailand, as well as for all the countries of Southeast Asia.

Since at least the middle of the last century, Tibeto-Burmese, Karen, and Miao-Yao upland peoples have migrated in increasing numbers into northern Thailand, Laos, and North Vietnam. These groups are ethnically different from the indigenous tribal groups and pose new problems for the societies into which they have moved. The new immigrant groups have in some cases disrupted the ecological balance between lowland and upland groups. They also have continuing relations with their relatives in China and Burma and maintain a communications system across national boundaries; this is often looked upon with mistrust by the rulers of the countries in which they now live. Finally, some of these groups are primary participants in opium production and trade—a source of considerable friction in recent years.

Ethnic and cultural factors are of critical importance in the present war in Indochina. While commitments to different ideologies underlie the fratricidal war of the Vietnamese, attempts to view the Indochinese conflagration in strictly ideological terms obscure the complexities and lead to misinterpretations of the motives of many of the actors.

For example, the montagnards, a tribal people of South Vietnam, are more concerned with their ethnic integrity than with the type of government residing in Saigon. The creation of autonomous tribal zones in North Vietnam, and the commitment by the National Liberation Front to create similar zones in the south, has great appeal to the montagnards, particularly since the South Vietnamese government has a poor record in dealing with upland minorities.

For the Khmer and the Lao the ideological coloring of the Vietnamese who have entered their territories is less important than that the Vietnamese are again making claims to control their destinies. The French-created fiction of Indochina has left a fearful legacy for the Khmer and Lao. On several occasions during the sixteen years of Cambodian independence the Khmer have expressed fear of Thai aggrandizement. Cambodia is ethnically the most homogeneous country of Indochina, partly because of territorial losses to her neighbors. In contrast, Laos faces major, possibly insurmountable problems in attempting to create a national entity out of the people of diverse cultures and histories willed to it by the French. Laos as a nation-state is a figment of the imagination.

Continued on page 74

LIFE IN THE SKY

"Within those cumulus puffballs and towering thunderheads, tiny animals and plants are living: eating, excreting, and reproducing"

by Bruce C. Parker

Two years ago, while studying lakes in the St. Louis area, I took a new detection device home to test in my goldfish pond. The device was a sampler designed to collect dissolved organic substances that might be important in understanding water pollution problems. One of the substances it could detect was vitamin B_{12}.

I started my goldfish pond experiments during the spring rainy season, and found almost immediately that the level of vitamin B_{12} in the pond water rose significantly following certain rains, especially those accompanying thunderstorms. Concurrently, algae in the pond grew luxuriantly, suggesting the possibility that these algae were stimulated by the vitamin or perhaps by other nutrients in the rainwater.

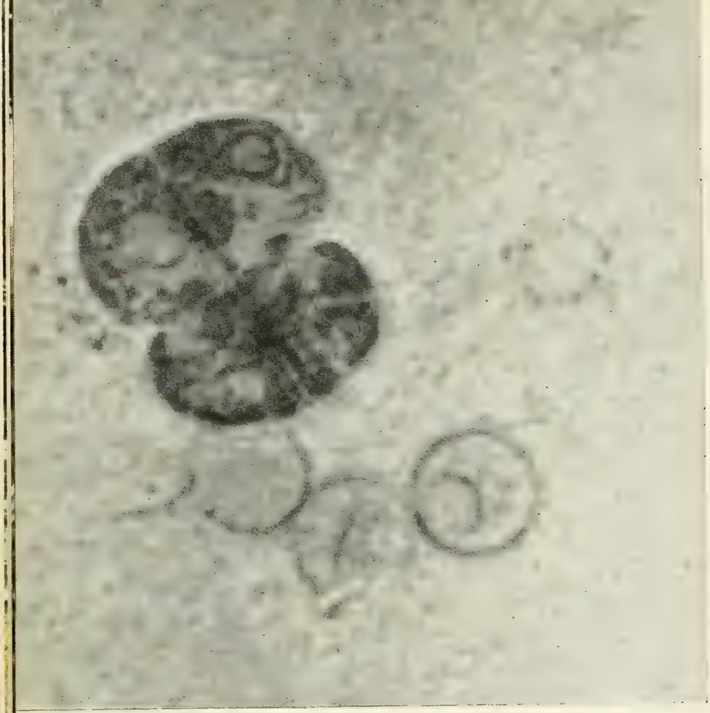
This discovery in my own backyard set me to collecting and analyzing rainwater for other organic substances. After two years of this work, primarily in Missouri and Virginia, it now seems clear that in addition to vitamin B_{12} other organic substances occur periodically in rainwater, including such natural vitamins as biotin and niacin. In fact, I determined that the total amount of organic matter in freshly collected raindrops, which had fallen through a relatively nonpolluted atmosphere, often exceeded that found in an equal volume of lake or sea water.

The discovery that rainwater can be a major source of essential natural vitamins and other nutrients immediately raised the question: "Where do they all come from?"

One might first suspect that the substances are somehow transported from the ground into the atmosphere. Because these vitamins are not gases at normal temperatures and pressures, their only logical mode of transport from ground to sky would appear to be in association with airborne dust, such as soil particles, pollen, or spores. But if pollen and dust from soil are major sources of soluble vitamins appearing in rainfall, one would expect to find correlations between the amount of airborne particles of these types and the concentration of vitamins in rainwater.

I found no good correlations of these sorts, except perhaps for niacin and biotin, which increased somewhat proportionally with the amount of airborne tree pollens. Vitamin B_{12} showed no clear relationship with the amount of pollen. Furthermore, I found no connection between the total amount of dust in rainwater and the occurrence of vitamin B_{12}, and I was unable to extract significant amounts of this vitamin from collected dry airborne dust.

These results all led to the conclusion that some process other than the capture of airborne dust by falling raindrops must bring about the high levels of certain biologically important substances dissolved in rainwater. In search of such a process, I speculated that clouds might be viewed biologically, as atmospheric ecosystems having significant numbers of functioning microorganisms. Such microorganisms, representing aeroplankton, do not have to be completely dormant



Green soil algae, magnified 450 times, thrive in a laboratory culture after extraction from airborne dust.

or in resting stages as with spores and pollens, but might under certain circumstances be capable of metabolic activity within clouds, producing, among other things, extracellular vitamins. Finally, intracellular vitamins might be released into solution by freezing in clouds.

In other words, within those cumulus puffballs and towering thunderheads, tiny animals and plants are living: eating, excreting, even reproducing.

While this hypothesis has not been proved, a number of facts suggest that it is entirely feasible. These include aspects of the physics of clouds, the chemistry of raindrops, and the distribution and metabolism of airborne microorganisms.

For some years cloud physicists have known that particles up to 50 microns in diameter (1 micron is about 1/25,000 of an inch) reside in clouds, especially continental ones. At least some of these particles function as nuclei for rain droplet condensation. While most condensation nuclei are of sizes smaller than those of microorganisms, at least a few particles from 0.5 to 50 microns in diameter occur almost universally in every cubic yard of cloud. Thousands of microorganisms have cells whose sizes fall within this range. Unfortunately, the difficulty of capturing and studying cloud particles of these sizes has largely prevented their detailed characterization.

Not all clouds would appear to afford ideal environments for many earth-inhabiting microorganisms. In terms of living, actively growing microorganisms, the environment of cumuliform clouds is of particular interest. Cumuliform clouds include the white, puffy cumulus clouds and the steeply piled cumulonimbus (thunder) clouds. Over continents the development of these clouds frequently accompanies strong updrafts. This same feature occurs for a special type of cloud, the orographic cloud, which forms from moist updrafts on the lee side of mountains. For thunderclouds the updraft velocity often exceeds 12 miles per hour, while associated horizontal velocities may exceed 75 miles per hour. But even lower updraft velocities are more than adequate to carry large dust particles, with their associated moisture and microorganisms, to high altitudes. Even in nontropical climates, such as the continental United States, cumulus clouds often occur at sufficiently low altitudes (2,000–20,000 feet) to have temperatures above 32 degrees Fahrenheit. Also, while temperatures sometimes are below 32 degrees, water often remains in liquid form in many clouds up to 20,000 feet because the reduced pressure at this altitude lowers the freezing point. Because many microorganisms, such as those inhabiting our polar regions can grow at 32 degrees, metabolic activity may be taking place within these clouds.

In terms of man's life-span, clouds are truly ephemeral. Some clouds form and dissipate in less than 30 minutes; others may last for days. Clouds do not necessarily rain, however; many begin forming, then dissipate. Important here is that we do not know the fate of a microorganism entering a cloud as part of the dust. In some microorganisms a few hours at optimum temperatures are sufficient for several cell divisions.

The process of water vapor condensation in clouds is complicated and still inadequately understood by cloud physicists. They have known for a long time that clouds contain more moisture than the surrounding cloudless sky, and that condensation nuclei play an important role in droplet formation. Condensation begins even before the air becomes saturated with water (when the relative humidity is less than 100 percent). No evidence excludes microorganisms as one fraction of these condensation nuclei in clouds, although the majority may be smaller than microorganisms. Furthermore, the larger the condensation nucleus, the more readily condensation occurs. This means that particles as large as microorganisms, however sparse, may well be the first to absorb, and the last to give up, their moisture. Cloud physicists have also shown that cumulonimbus clouds have fewer numbers of droplets per unit volume than other cloud types, and that the droplet sizes are the largest. Furthermore, the total amount of water per volume of thundercloud is greater than for all other cloud types.

I have already noted that clouds contain appreciable moisture and that once condensation has begun, the distribution of water occurs as droplets. Thunderclouds contain droplets of the largest size, their mean radius approaching 100 microns. In thunderclouds, growth of droplets of such size often requires more than an hour and a half. Generally, photosynthetic microorganisms are unable to grow and conduct normal metabolism at light intensities as high as those occurring on bright, uncloudy, sunny days. The light intensity in clouds is, however, much reduced, and perhaps more optimal for photosynthesis. Also, energetic ultraviolet solar radiation harmful to microorganisms is, by and large, filtered out by the ozone layer high above the highest cumuliform clouds, and still further by the cloud moisture.

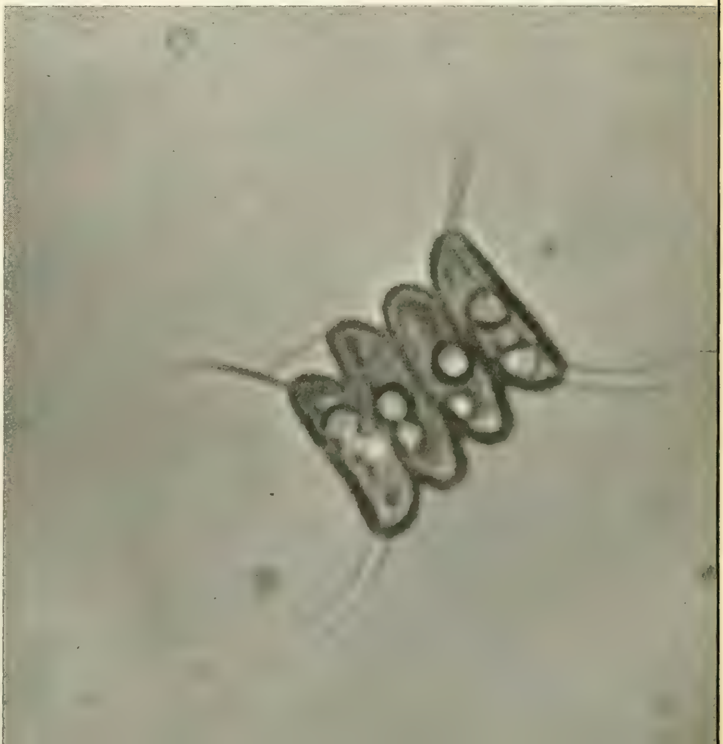
This distribution and content of moisture in clouds, together with the tendency for moisture to condense around particles, makes it possible that some airborne microorganisms are associated with water droplets in clouds, thereby having sufficient water to perform metabolism.

Nutrients are also important if, in addition to cell metabolism, growth is considered. No doubt, a significant amount of potential nutrient comes from gaseous or volatile phases of substances. In addition to such well-known, biologically important gases as carbon dioxide, oxygen, and nitrogen—which dissolve readily in water droplets—trace amounts of nitrous oxide, ammonium, other oxides of nitrogen, sulfur dioxide, carbon monoxide, methane, butane, acetone, and butyl alcohol also occur in unpolluted air. Also, we know that plants give off volatile organic substances, such as terpenoids. Rising in convection currents into the atmosphere, they interact with ozone, aggregate, and may to some extent function as condensation nuclei for rain. Such volatile substances are often seen in desert environments where they appear as a natural haze.

Essential nutrient elements such as phosphorus, potassium, calcium, magnesium, and iron are not volatile, but could be borne into the atmosphere by soil and other dust particles. It is questionable whether these nutrients would be essential for microbial metabolism and limited growth in clouds because many microorganisms are known to store surpluses of nutrients. For example, algae accumulate excesses of phosphate, which enables them to continue growth for many cell divisions even when phosphate becomes scarce in the natural environment.

As noted previously, there are few biological data for clouds. We know that viable airborne microorganisms, called aeroplankton, occur throughout the lower atmosphere. These include bacteria, fungi, and algae. Many pollens, seeds, insects, feathers, spiders, and spider webs have also been collected.

Recently, R. Malcolm Brown has reported the distribution of algae in air among the Hawaiian Islands. When a dish containing a culture medium (mineral agar) was exposed to air from a moving automobile or airplane, then exposed to light for about two weeks in the laboratory, a great variety of mi-



Another species of live soil algae, taken from a cloud, proves that aeroplankton remain viable while in the air.

The water droplets in thunderstorms are large enough for microorganisms within them to metabolize.

croorganisms (algae, fungi, bacteria) grew into visible colonies. Brown's data reveal that large numbers of viable algae and other microorganisms occur in orographic clouds of Hawaii, while almost no microorganisms occur above these clouds. These data, of course, do not prove that microorganisms are metabolically active in clouds, only that they reside in a viable state therein.

I used dry airborne dust accumulated on filters in two series of experiments. This dust was collected 50 feet or more above ground level and at relative humidities below 100 per cent, so there was no free moisture associated with the dust samples.

The first series of experiments involved placing these dry dust samples beneath a microscope and moistening them with a drop of water containing small amounts of a chemical known as TTC, which in dilute solution appears colorless or pale yellow. It is absorbed by living cells and attacked by enzymes that remove specific hydrogen atoms. The resulting product is a water-insoluble, pink compound known as formazan. Because these enzymes occur in nearly all viable microorganisms and because they are generally absent from cells that have been dead even for a relatively short period, one can apply a dilute solution of TTC to a suspension of cells and obtain some idea of their potential viability. When the freshly collected air dust was moistened with TTC solution, numerous cells became visibly pink in fifteen to twenty minutes. Now, a resting or dormant cell normally requires from one to many hours to absorb and convert sufficient TTC to achieve visible concentrations of pink formazan. Therefore, these results suggest that some microorganisms in air occur in vegetative, nonresting stages. Direct microscopic observation of air dust also suggests that numerous microorganisms occur in nondormant stages. For example, I observed numerous algae as vegetative cells that were indistinguishable cytologically from algae grown in my laboratory. Also, a number of these algae are not known to have resting stages.

In a second series of experiments, filters containing dry air dust were placed in transparent plastic chambers. The chambers were sealed, and a measured volume of radioactive carbon dioxide was injected into the chambers without breaking the seals. As controls I used identical chambers injected with radioactive carbon dioxide, some containing filters without dust and others containing filters with dust that had been presterilized to kill any existing microorganisms. After 24 hours' exposure to the radioactive gas in either darkness or fluorescent lighting, these chambers were opened and the filters removed and treated with dilute acid and formalin to remove adsorbed or replaced radioactive carbon and to stop all further biological activity. Then all filters were counted for radioactivity. Repeatedly there was higher radioactivity with the nonsterile, air dust filters than with the sterilized controls. Light-exposed, nonsterile filters usually had highest radioactivities, while dark-exposed ones often followed a close second. These preliminary findings leave little doubt that fixation of carbon dioxide into organic matter, both in light (photosynthesis) and in dark, occurred.

The important point is that numerous metabolic reactions, those associated with light and dark in-

corporation of carbon dioxide into organic matter, had taken place in these experiments under conditions involving an atmosphere subsaturated with water vapor. Thus, while the relative humidity was less than 100 percent, apparently some viable microorganisms possessed sufficient water associated with their cells and neighboring dust particles to undergo measurable metabolism.

Admittedly we are perhaps a long way from demonstrating directly that clouds are living microbial ecosystems in the sense of lakes or soils. We know only that some clouds contain viable microorganisms, that these microorganisms need not necessarily be in resting or dormant stages to survive, and that the physical and chemical properties of some clouds should, in theory, afford environments compatible with growth and metabolism of some microorganisms. The vitamin B_{12} apparently produced in some clouds hints that something is in fact going on.

In the absence of direct evidence, the idea that clouds are living ecosystems must remain hypothetical, but the search for such evidence should receive more than passing interest, however, because an understanding of the biology of clouds could have considerable impact on other areas. For example, clouds may play significant roles in the dispersal of microorganisms and chemicals. Some of the microorganisms may be pathogens, and consequently involve the mechanisms of the spread of disease. The chemicals may be of natural origin, such as the vitamins now known to occur in some rains in significant concentrations. Also, synthetic chemicals may occur in clouds. Such pesticides as DDT have already been detected in some rains and associated with airborne dust. We know also that levels of DDT no greater than those reported from such rains can inhibit photosynthesis in marine phytoplankton.

Finally, we might speculate on the role of clouds in air pollution. Cloud formation may accompany accumulation of numerous water-soluble, airborne substances. If microorganisms do occur in clouds and are capable of metabolic activity, they may not only be affected by air pollutants but may modify these pollutants before they rain out from the cloud ecosystem. Indeed, one might envision some future technology capable of seeding clouds with microorganisms or manipulating the microbial composition of clouds in some manner to change or reduce the pollutants in our atmosphere.

Orographic clouds, which form when moist air is forced upward by mountains, appear to be good candidates for living ecosystems.

MADE IN JAPAN

Owls of grass, horses of wood, men of cocoons and stone – a gallery of folk toys expresses the ageless charm of simple design and indigenous materials

by Rodger Mitchell

photographs by Tom Beiswenger

The Japanese produce about 90 percent of the world's souvenirs, made by affixing different decals to a few standard models stamped out of plastic or porcelain. We have few alternatives to these unimaginative mementos, but the Japanese themselves have a treasure of indigenous local toys from which to collect reminders of travel in their own country. Produced by a cottage industry that antedates plastics and assembly lines by more than two hundred years, some of these toys are purely decorative, others are playthings for children; but by definition a local toy must be associated with a single place in Japan. Such toys are often made of a material found in the area—a special stone, wood, or grass—and many of them refer to local legends or stories.

Toy owls sold at the Zooshigaya Temple in Tokyo, for instance, are made from heads of *zakuro*, a tall grass that often grows on the dikes surrounding rice paddies. The owl-making tradition, said to go back 400 years, supposedly began with a young girl who was unable to pay for her mother's medicine. She went to Zooshigaya Temple to pray to the goddess Kishibojin—a female demon who ate children until Buddha taught her to prefer pomegranates. The goddess appeared to her as a marvelous talking butterfly and advised her to make owls of *zakuro* grass and sell them at the temple. The scheme was so profitable that the girl was able to buy the medicine to cure her mother; in fact, manufacturing the owls was such an ideal occupation for the children and women of the family that to this day three families, each claiming descent from that girl, make these owls.

The heads of grass from which the owls are made are a reminder to the Japanese of the bright fall days when the sun makes the grass heads sparkle. Despite the intense urbanization of the Japanese, as individuals they still live by the seasons and enjoy many seasonal activities reminiscent of simpler times. Of course many of the seasonal traditions and activities have been lost, and others are remembered only by the elderly. Certainly, collecting bagworms in the fall is not as important as it once was. Not too many years ago the sturdy bags of the bagworm caterpillar were collected, cut open, and stitched together to make small purses. Bagworms are still collected near the city of Otsu and are used to make a toy representing a monk who had been careless with temple funds. The monk was in despair because the temple needed repairs and no one would make contributions. A stranger stopped at the temple and suggested that if the monk wore the mask of the temple guardian, Jizo, he would have success when begging for alms. The monk, however, was not only careless with temple funds, he was incompetent as well and made the mistake of taking the mask of one of the mischievous demons, *oni,* instead of the mask of the temple guardian. This resulted in people laughing and throwing stones at him until his straw cape was so tattered that it looked like a bagworm cocoon. The common name for the bagworm in Japan is "straw-cape bug," *mino-mushi.*

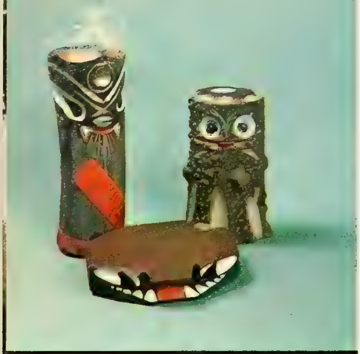
The *oni* face on the bagworm toy is a folk imitation in the style of Motabei Iwasa (1578-1650), a painter of scrolls that now hang in the Onjoji Temple in the city of Otsu. These toys are called *Otsu*-e, "Otsu pictures," and a wide variety of toys, made by various families in Otsu, are sold at the temple gates. By far the most useful of these *Otsu*-e is the child-protecting *oni.* Originally devils, Buddha eventually tamed *oni* and made them serve men; nevertheless, they still remain somewhat unpredictable and are not above using trickery for their own amusement.

Almost all of these toys come in small, decorative boxes, which also contain written explanations of the stories behind the toys. The child-protecting *oni,* for example, is said to frighten off the spirits that make children cry. Since crying was formerly blamed on evil spirits, it followed that children cried only if the *oni* was neglecting his duties. A wise parent would therefore keep an *oni* toy on hand at all times. Just a glimpse of the *oni,* who laughs and cries at the same time, is said to cheer anyone who is sad.

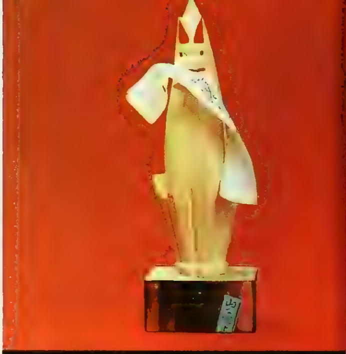
Japanese toys often carried a charm or expressed a hope for the future of a child. Horses, for instance, were considered to be messengers of the gods, and since the horse epitomizes the virtues of strength and reliability, each one of the hundreds of horse toys is supposed to remind one to honor the gods, who gave horses to men. In addition, boys who play with toy horses are supposed to acquire the horse's virtues.

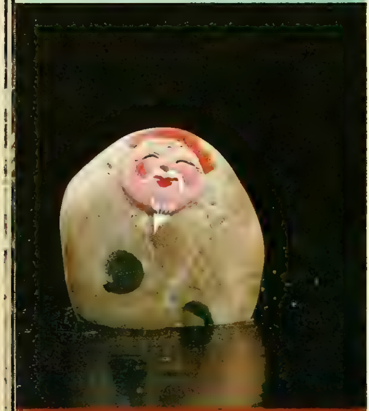
In several areas of Japan, boys ride gaily decorated horses to the temple on festival days as a reminder of ancient times when samurai who had been successful in battle gave their horses to a shrine. The most famous of these festivals occurs at Marioka City on Boy's Day, when horses decorated with bright ribbons and bells are ridden to the shrine. One of the toy horses made in this area is called *changu-changu-*

The sound of prancing belled horses in the Boy's Day celebration at Marioka gives this festive toy its name—*changu-changu-umako*

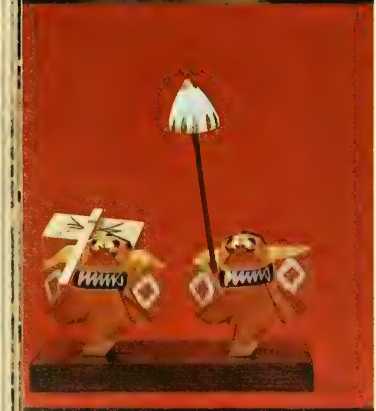


Evil spirits are turned aside by these carved talismans. Sansho (right) represents a spirit of the mountains who is heard as an echo. Made from the branch of a tree belonging to an ancient genus, he is carried by woodsmen for good luck.

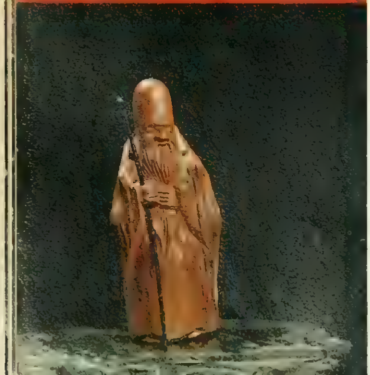




This stone from Awaji-shima has had its personality revealed by the artist Empe Ogura. An old man of great reputation, Ogura works with stones he collects on the beach near his home.



Servants of a nobleman, carrying decorated lances and treasure boxes, parade on the arrival of his household in Tokyo. These parades were common during the feudal period when noblemen had to alternate residences between their local estates and Tokyo.



The seven gods of fortune are said to have been devised by the priest Tenkai when asked by the shogun what constituted natural nobility. The answer: longevity, fortune, popularity, candor, amiability, dignity, and magnanimity. Fukurokuji, at left, represents popularity. He is made from the weathered, broken end of a cypress branch; only the features are carved and the rough surface of the break forms his robe.

ıd example of the traditional
of folk carving called *itobori*,
/hite fox was cut in straight,
l strokes that are never altered
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tional mementos of the Deer
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creature at left represents a
k worn in the festivals of
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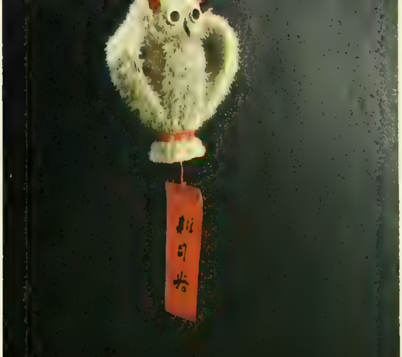
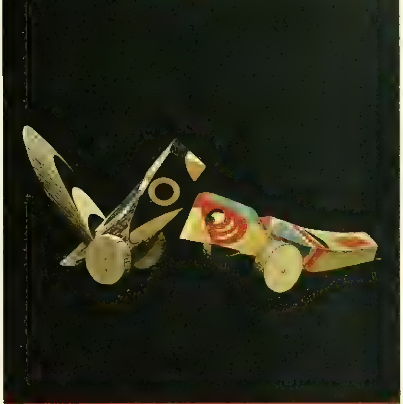
ime when the lord of Kaga was
dden to train an army. So his
rals simply invented dances
would develop fighting skills.

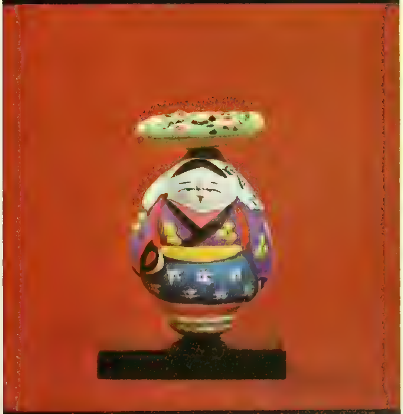
ıs once customary for a
ırious samurai to give his horse
shrine as a gesture of gratitude
e gods. Now a variety of straw
.e toys are made as tokens to
ɛft at shrines.



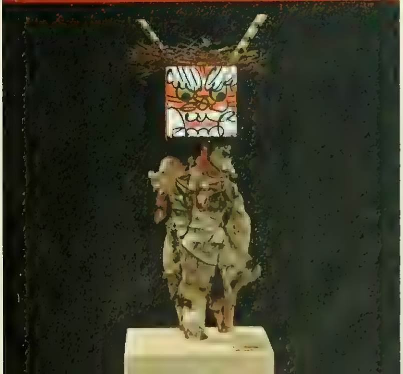
Owls of *zakuro* grass are woven by three Japanese families and sold at a Tokyo temple.



Many Japanese playthings involve a minimum of labor. These rough-cut wheeled birds are still made as they were in the tenth century, when the men of the Heike clan were driven out of Kyoto and spent their idle days making toys.



For ten centuries young girls have carried flowers from a shrine in Shirakawa to the Gosho Imperial Palace in Kyoto on April 7. This doll represents the Shirakawa maiden.



A monk who had been careless with temple funds is represented here wearing the mask of a mischievous demon. The body of this toy from Otsu is the cocoon of a bagworm, a larval moth that covers its cocoon with leaves, sticks, or pieces of bark.

umako, to suggest the sound of the prancing of a belled horse. Constructed of seven rectangular pieces of kiri wood, the toy is heavily decorated with cloth and small metal bells.

The word *umako* means little horse. There are at least three other styles of toy horse made in Marioka City, and these horses are called *kuro-goma. Kuro* means black, and *goma* is used for horse because it is easier and more euphonious to say *kuro-goma* than *kuro-uma.*

Black horse toys are made in many villages and towns, but the oldest and most famous come from the village of Miharu. Called, of course, the *Miharu-goma,* this horse is supposed to be a reminder of a famous battle held in A.D. 782. At that time General Sakanoue-no-Tamuramaro set out from Kyoto to conquer the northern barbarians. Before he left Kyoto, the Buddhist priest Entin, founder of the Kyomizu Temple, made a hundred horses from lumber scraps left over from the construction of the temple and gave them to the general, who put them into his armor case for good luck before traveling north to battle. The battle was joined near the present site of Miharu. Just when the general was sure he would suffer defeat, the hundred little horses came to life and overran the enemy's camp. It is said that the villagers of the area have been making horses identical to Entin's original model ever since the battle, but there are skeptics who say that the tradition was established only two hundred years ago. Whatever the truth, the *Miharu-goma* follow a single model and are instantly recognizable as a token from Miharu that will bring strength and manliness to young boys.

The creation of local Japanese toys has been a continuous process, and often an old story will inspire a new toy. The *nue* is such a toy. It was created by the modern painter, Amashiko Ishida, who while on a holiday in southern Japan was reminded of an eleventh-century tale of a beast with the body of a badger, the legs of a tiger, the tail of a snake, and the head of a monkey. This remarkable animal was reputed to move from rooftop to rooftop singing in a voice that sounded to ordinary mortals like the voice of a nightingale. Emperors, however, are the descendants of the gods and therefore hear things very differently. To them the song of the *nue* is the voice of utter chaos and confusion and brings sickness and death.

During the reign of the emperor Shirakawa Howo some 800 years ago, a *nue* took up residence on the palace roof, causing a crisis in the royal household. The emperor asked his most resolute samurai, Minamoto Yorimasa, to help him. In spite of the curse that would fall upon him, Minamoto vowed to destroy the *nue.* A famed scholar and warrior, he was noted for his single-minded pursuit of any goal. Displaying these virtues to the fullest, he hid in the palace grounds and when the *nue* came, dispatched it with a single arrow.

The word *nue* has many meanings in Japanese and some of these are associated with the fabled beast. In earlier usage *nue* meant chaos and irrationality because the animal was a confused mixture of the elements. The word has come to mean "gossip," and so the toy reminds one not to ruin his reputation through idle talk. It is also used as a basis for telling a child the story of Minamoto and reminding him to act on the premise, "Don't doubt—decide clearly between good and evil and act as Minamoto did." Although the *nue* is a modern creation, it reflects the tradition of local toy makers rather than the gaudiness of twentieth-century industry.

The natural materials of the older toys often form a part of their significance. A toy from Lake Toro on the northern island of Hokkaido, for example, is made from seeds that are the burrlike fruit of an aquatic plant called *hishi.* The seeds are used by the Ainu both for food and for making wine, and as with most elements in the world of the Ainu, the *hishi* plant has its protecting spirit who must be properly placated and thanked for his gift to man. Consequently, a festival to honor the spirit of the *hishi* is held in late summer just before the harvesting of the seeds begins. The festival's dances have become a tourist attraction, and the toy, made of painted *hishi* seeds, depicts the ceremonial dancers.

By directing attention to some aspect of nature, most of the toys help nurture an awareness of nature and the heritage of Japanese culture. Despite industrialization the Japanese are close to the land and the sea. Fish are an important part of their world, and the supply of fish is clearly dependent upon the season and the weather at any given moment. Because fish is often served raw it must be very fresh so that the proper delicacy and flavor are retained. It is considered a gentlemanly accomplishment to be able to order the best variety of fish at the peak of its season, and the mastery of this ability might begin in childhood with the toys representing various well-known fish caught off the coast of Japan.

One of these, the *hata-hata,* is a kind of puffer and has inspired a toy showing the graceful simplicity of traditional Japanese playthings. *Hata-hata* are caught in the fall of the year when they come close to the shore to breed. Because the weather is generally stormy then, and because the fish appear in large groups that resemble black clouds, they have been given a second name of thunderfish, *kaminari-uo.* At one time, in a province of northern Honshu, overfishing of *hata-hata* became a problem and the governor of the province ordered the people to stop taking this fish. But *hata-hata* fishing continued; the fishermen simply began to call the fish *buriko.* The *buriko,* however, is quite unlike the *hata-hata* in every respect but its similar egg mass. Fishermen may have claimed that they were selling *buriko,* but no one would be fooled if they looked at the fish.

Such complex word associations are as much a part of everyday life in Japan as they are a part of Japanese poetry. Like the *haiku* verses that create images with only a few words, Japanese toys reflect the delight of their creators in the world around them—a delight also expressed in their stories, in the objects they use in their homes, and in the souvenirs they collect as reminders of their travels.

hata-hata, a puffer caught off
oast of Japan, is re-created in
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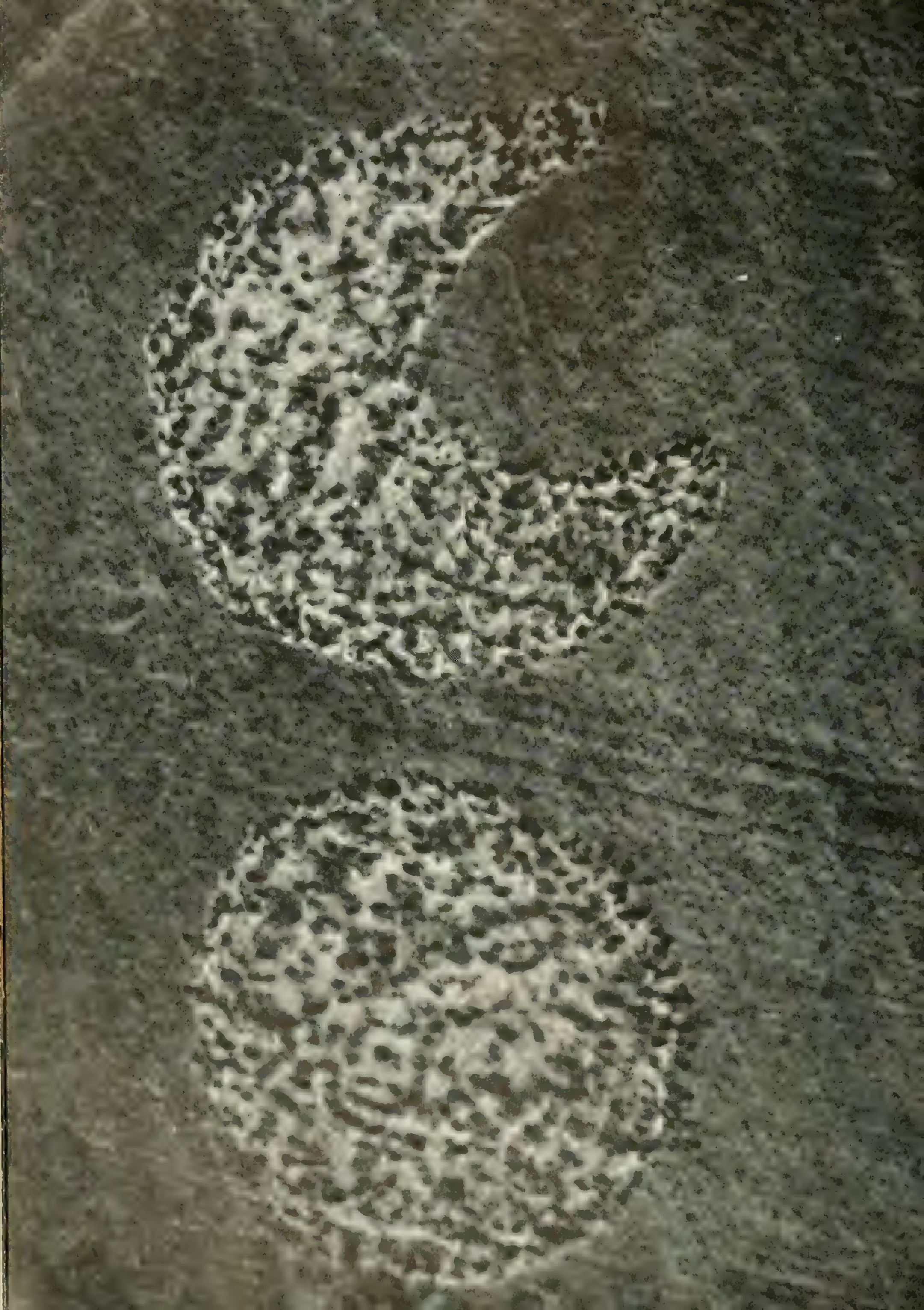


Dissecting the Crab

From naked eye to X-ray detector, every instrument man has used to study the Crab Nebula has revealed more about stellar catastrophes

by Geoffrey Burbidge

More than 7,000 years ago a star in the constellation Taurus reached the end of its normal life. Its inner part started to collapse and its outer envelope followed. By some process that we don't properly understand, the implosion was converted to an explosion, and tremendous quantities of energy in the form of gamma rays and neutrinos were released, followed shortly afterward by optical radiation that made the object one of the brightest in the sky. The light from that explosion took more than 6,000 years to reach the earth, where it was detected by Chinese and Japanese astronomers on July 4, 1054. Although thousands of light-years away, the object was seen in daylight in Peking for 23 days, and could be seen at night for about two years until it faded.

Not only was it seen in Asia; it was probably also seen in North America by Indians who depicted it in cave drawings in northern Arizona. William Miller, staff photographer at the Hale Observatories (Mount Wilson and Palomar), has proposed a highly plausible interpretation of two ancient drawings that he and Helmut Abt found: one in a cave, the other on a canyon wall. Miller demonstrated that the circle and the crescent, highly unusual in such drawings, most likely represent the crescent moon with a very bright star near or just below one cusp. He calculated the position and phase of the moon for early July, 1054, and asked anthropologists to investigate the probability that Indians were living at the site at that time. He found that the moon was 2 degrees (about four times its apparent diameter) north of the position of the exploding star just before dawn on July 5, 1054, and that Indians were living at the site sometime between 900 and 1100. Thus, both arguments favor the idea that the Indians had recorded their sighting of the supernova.

In the place of the bright star that appeared in the sky in A.D. 1054, we now see the remarkable nebula known as the Crab. How do we know that it is the remnant of the supernova, and what is it doing now? It appears that the nebula was first recorded in the astronomical records by an English physician, John Bevis, in 1731. He prepared a set of star charts called the *Uranographia Britannica*, but it was never published because the cost of the engraving was so high that the printer went bankrupt and the plates went to the creditors. The charts appeared later, but without any acknowledgment to Bevis. In 1758, the nebula was independently discovered by Charles Messier, who, at the time, was looking for the first predicted return of Halley's comet. He wrote, "The comet of 1758, the 28th of August, being between the horns of the Bull, I discovered below the southern horn and a short distance from the star zeta of that constellation a whitish light elongated in the form of the light from a candle, not containing any star." In Messier's famous Catalogue, he gave it the number M1, but attributed its first discovery to Bevis.

The well-known astronomers of the nineteenth century, the Herschels, Lord Rosse, and William Lassell, observed the nebula and wondered if it could be made up of stars. Lassell decided that this was not true because while stars can be seen over the face of the nebula, they are not more numerous than those in areas outside the nebula. It was first photographed in 1892 by Isaac Roberts with his 20-inch telescope; then successively by the early astronomers at the Lick and Mount Wilson Observatories, using larger telescopes. From these photographs it became clear that because of its shape and its peculiar filamentary structure, the Crab was a unique object among the thousands of known nebulae.

The next remarkable discovery was the work of Carl Lampland at the Lowell Observatory in Flagstaff, Arizona, and John Duncan at Mount Wilson. In 1921, with photographs taken several years apart, they demonstrated that the structure of the nebula appeared to be changing. Duncan showed that twelve of the outer filaments were moving outward. Thus, they concluded that the nebula was expanding at a measurable rate. Only a few years previously two novae, Nova Persei and Nova Aquilae, the

Indian drawings in Navajo Canyon, northern Arizona, depict the Crab supernova below a crescent moon.

first exploding stars to be discovered, had been shown to have expanding shells. A few years after this Edwin Hubble pointed out that if the Crab had been expanding constantly at the rate measured by Duncan, it must have started from a central point about 900 years before.

The detection of expansion suggested that some kind of explosion had occurred, and Crab's position relative to the position and brightness of the new star reported by ancient Chinese and Japanese astronomers led the Swedish astronomer Knut Emil Lundmark to suggest, in 1938, that the object must have been a supernova. In a previously published list of the ancient Chinese observations of novae, he had noticed that in 1934 a Japanese historian, Iba, had found independent evidence in ancient Japanese records of the appearance of the new star in 1054. The Japanese astronomers had stated that the star was as bright as Jupiter. This information, that a star appeared as bright as Jupiter although it was 5,000 or 6,000 light-years distant, forced Lundmark to the conclusion that the star was much too bright to be a nova—it must have been a supernova.

Supernovae were first investigated and christened early in the 1930's by Walter Baade and Fritz Zwicky. They were describing exceedingly bright objects that flare up in other galaxies and, in some cases, become as bright as the whole galaxy for a short period. Their light then decays over many hundreds of days until it eventually fades below the level of detection. It is estimated that one occurs in our galaxy about every 50 years; we can only see those in our part of the galaxy, however. Our own sun could explode in another five or six billion years.

At the time of the discovery of supernovae, Baade and Zwicky made several startling predictions. They felt that the energy output was so great that a whole star must be effectively shattered. They also suggested that supernovae might well be the sources of cosmic rays, and that the remnant left after the explosion might be a neutron star—an extremely dense object in which the electrons and protons in the nuclei of atoms have been crushed together to form neutrons. The importance of these suggestions will become apparent as our story of the Crab unfolds.

By the late 1930's the realization that the Crab was the only known supernova remnant that could be studied in detail stimulated great interest. For example, Jan Oort, now director of the Leiden Observatory, interested the Dutch orientalist J.J.L. Duyvendak in the supernova's early history, and it was he who uncovered the details that led Oort and Nicholas U. Mayall in 1941 to the conclusion that the Crab and the supernova of 1054 were identical, and that this supernova was one of the most luminous ever detected.

At this stage the first studies of what can properly be called the physics of the Crab began. That is, what are the physical conditions as we see them at present, and how does the Crab continue to radiate so powerfully?

Walter Baade and Rudolf Minkowski made the first detailed investigations with the 100-inch telescope on Mount Wilson in 1937. They showed that the nebula was made up of two kinds of radiating regions. There is a filamentary network made up of gas heated and ionized by strong ultraviolet radiation and containing such elements as hydrogen, helium, oxygen, neon, and sulfur. Electrons are stripped away from atoms leaving ions. Minkowski and later Lodwijck Woltjer, then a student of Jan Oort, and others found values for the density of the gas in the filaments—about 1,000 electrons and ions per cubic centimeter—and the temperature of the gas—some tens of thousands of degrees. For all of the elements studied, with the exception of helium, they found that the composition of the gas is similar to that found in most young stars and also in the solar system. Helium appears to be much more abundant than it is in normal stars, however, and we believe that this must be a result of nuclear processes that took place immediately before or during the explosion.

How much matter is present in the filaments? If one knows the density and can estimate the fraction of the Crab's volume that is filled with this hot gas, the mass can be estimated. The calculations have ranged from about 1/10 to the modern value of about 1/2 the mass of the sun.

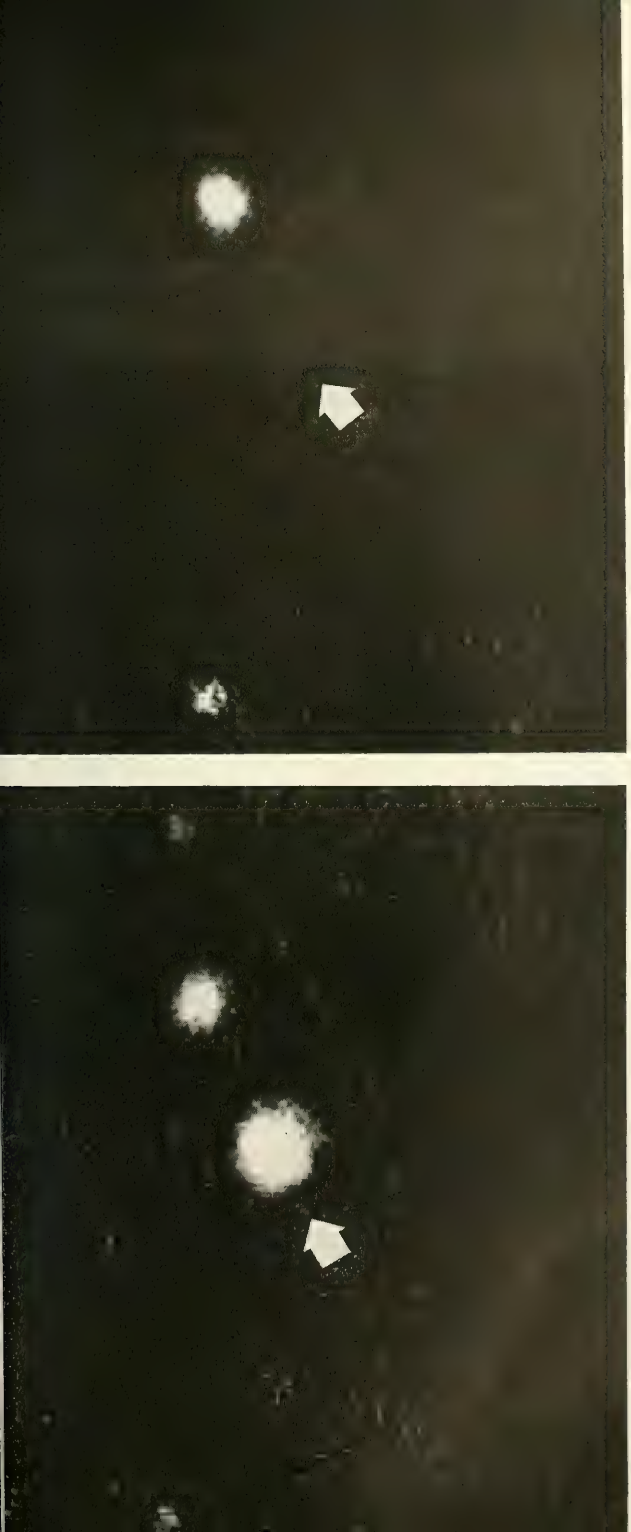
The other component is a large amorphous region. It is this component that was so difficult to explain when it was first isolated. The natural explanation was that it was radiation emitted from a much hotter gas cloud than the clouds making up the filaments.

The next major discovery that bore directly on this last question came with the advent of radio astronomy in the late 1940's. One of the first powerful radio sources to be discovered was named Taurus A—the most powerful source in the constellation Taurus—and in 1949, Bolton, Stanley, and Slee, in Australia, identified this radio source with the Crab. It was one of the earliest sources to be identified with an optical object, but at the time there was little, if any, understanding of the mechanisms that were giving rise to the powerful radio sources. The most obvious one was that radio sources were really thermal sources—radiating in an easily predictable way at all wavelengths.

But the temperature needed to emit the radio power radiated by the Crab (about 100 times more than the total optical radiation from the sun and a few percent of the optical radiation from the Crab) would require impossible conditions in the gas. Thus, a different kind of mechanism, a nonthermal mechanism that would tend to concentrate energy in restricted parts of the electromagnetic spectrum, seemed to be indicated. Soon it became clear that the spectra of the radio sources had shapes that also suggested that they must have a nonthermal origin.

The German astrophysicist K. O. Kiepenheuer and the Swedes H. Alfvén and N. Herlofson first proposed that cosmic radio waves were being emitted by the so-called synchrotron process. This is a classical radiation process in which charged particles emit radiation as they spiral in a magnetic field. In this process, the characteristic frequency of the radiation is determined only by the mass and charge of the particle, its energy, and the strength of the magnetic field in which it moves. The process is highly inefficient for all particles but electrons. Radio radiation in the frequency range observed could easily be expected, however, if the particles were extremely energetic and the magnetic fields were very weak by terrestrial standards. An important property of radiation emitted by this process is that it is highly linearly polarized. This means that the image of an object radiating by this mechanism will look very different as one rotates a piece of polaroid in front of the image plane.

It was the Russian astrophysicists S. B. Pikelner, V. L. Ginzburg, and I. S. Shklovsky who, in the early 1950's, first proposed that the synchrotron process was responsible for the radio source in the Crab. But they went much further. They suggested that the mysterious, continuous optical radiation arose from the same process and pointed out that a test of this idea would be to determine if the optical radiation was polarized. This was done at the Byurakan Observatory by Vashakidse and Dombrovsky, then in



Images built up by carefully timing exposures during a large number of cycles show the pulsar at minimum light, above, and at maximum light, below.

more detail by Oort and Walraven in Holland and by Baade at Palomar. A very large amount of linear polarization was found, confirming the hypothesis. This was a great step forward, because not only was the optical radiation explained but the synchrotron theory for radio sources was firmly established. Even more remarkable were the deductions that could be made about the energy sources in the Crab. It was now apparent that the object contains a vast number of very high-energy electrons, spiraling about the weak magnetic field threaded through it. These electrons emit the optical and ultraviolet radiation that excites the gas.

The Crab is a gigantic cosmic accelerator. The total amount of energy carried by these particles and in the magnetic field is at least equivalent to all the energy emitted by the sun in the last million years.

Now, while we can deduce directly from the presence of this synchrotron radiation only that high-energy electrons are present, we have every reason to believe that high-energy protons (the nuclei of hydrogen atoms), alpha particles (nuclei of helium atoms), and heavier nuclei are also present in great numbers, and in total energy they may be more important than the electrons.

We have, therefore, reached a point at which we have good reason to believe that a supernova remnant is a very powerful source of high-energy particles, with just the properties that are found in the primary cosmic rays that continuously bombard the earth and are apparently spread thinly throughout our galaxy. It was natural therefore for the Russians Ginzburg and Syrovatsky to propose that the Crab Nebula and other supernova remnants are the sources of cosmic rays in the galaxy. This, then, was a revival of the early proposal of Baade and Zwicky, made some twenty years before, that supernovae were the sources of cosmic rays. This supernova origin theory has been developed extensively in the last fifteen years, particularly by Ginzburg and Syrovatsky. While it has gained a large measure of support, some, including Fred Hoyle and myself, have suggested an alternative and, in some ways, even more spectacular proposal; namely, that the strong radio sources spread throughout the universe and the exploding nuclei of galaxies are generating cosmic rays at such a high rate that they fill the whole universe at the density seen in our galaxy. If this turns out to be true, supernovae contribute only a small part of the universal cosmic rays.

But let us return to the Crab. Having shown that it is a great reservoir of very high-energy particles, is it reasonable to suppose that these particles were originally produced in the supernova explosion of 900 years ago? The rate at which the electrons radiate their energy is determined by their energies and by the magnetic fields in which they are moving. The larger the energies and the stronger the fields, the more energy they radiate. At the same time, the higher the electron energy and the stronger the magnetic field, the shorter will be the wavelength of the radiation. This means that the electrons radiating radio waves (radio electrons) will radiate more slowly than those radiating light (optical electrons). It turns out that the radio electrons that were accelerated when the supernova exploded can go on radiating for a hundred thousand years or more, but the optical electrons present now will lose their energy in only about 100 years, a short time compared with the age of the Crab.

This reasoning led to the conclusion that even 900 years after the explosion there must still be some very powerful source continuously pumping high-energy particles into the nebula.

There was indeed some direct evidence from the photographs of continuing activity in the Crab. Walter Baade photographed the nebula from 1937 until the late 1950's, when he retired. He discovered some remarkable light ripples near the center that appear somewhat irregularly several times a year. They seem to move at very high speeds, perhaps a tenth or more of the velocity of light, and disappear a short distance from the central star. In recent years they have been studied in more detail by Jeffrey Scargle, a young astronomer now at the Lick Observatory. It is thought that the ripples are the result, not of material motions, but of wave motions, perhaps involving the magnetic fields; these are called hydromagnetic waves. When Baade first described these, various theoreticians thought that, in some way these waves must be continuously accelerating the particles. As we shall describe, however, it now appears to be somewhat more complicated than this.

By the 1960's it was the turn o the X-ray astronomers to add to the mystery of the Crab. X-ray astronomy is a young branch of astronomy—only about five years old. To see what the universe looks like at X-ray wavelengths we must observe it from above the earth's atmosphere. Thus, observations have to be made using telescopes attached to rockets, which spend only about five minutes at altitudes o about 60 miles; balloons, which can be made to rise to altitudes of 120,000 feet or more and remain ther for a few hours; or, best of all, satellites, which can stay in orbit and make observations for years. In th last few years, 30 or 40 X-ra sources have been found, mostly using balloons and rockets, but onl two or three have been definitel identified with optical objects. Inevitably, one of these is the Crab. A X-ray source was already known t be in the vicinity of the Crab, bu its position was not known accurately. The identification of th Crab as a source, as well as a roug determination of the size of th source, was made by Herbert Friedmann and his colleagues at th Naval Research Laboratory. Wai ing until the moon was about t pass in front of the Crab (a luna occultation), they launched rocke timed precisely to observe the X ay source as the moon occulted the Crab and then as it appeared again. They found that the X-rays were dimmed and then extinguished altogether as the occultation occurred, and then reappeared. By this means they established conclusively that the X-ray source lay in the Crab Nebula. They also showed that its size, although somewhat smaller than the optical nebula, is still large, perhaps between one and two light-years across. Many observations have now been made showing that the Crab is an exceedingly powerful X-ray source.

What is the process responsible for this radiation, which is much more powerful, perhaps by a factor of 50, than all of the energy emitted in the optical part of the spectrum? It is generally thought that this is also synchrotron radiation, but, if electrons are to emit radiation with wavelengths as short as those of X-rays, much higher energy particles still, or much stronger magnetic fields, or both, are required. Such X-ray electrons will have much shorter lives than the optical electrons, perhaps only a few months long, and certainly not more than a year or so. This limitation places even greater demands on the energy-generating machine, which we have not as yet been able to explain. Because the particles have lives of only a year or less, they would lose most of their energy long before they reached the outer parts, particularly since they must be spiraling in the magnetic field and cannot be moving in straight lines. Therefore, it is hard to understand how they can make a source as big as the one we see if they were only injected at a single central point.

By now it should be clear that while the modern discoveries associated with the Crab had opened up a whole new field of investigation that told us much about the high-energy processes that go on after a supernova explodes, they had not yet led us to any real understanding of how such an energetic object maintains itself.

Then the pulsars descended on us.

Pulsars are radio sources that emit pulsed signals at exceedingly regular intervals; the first one discovered did this every 1.337301109 seconds. Just about two years ago, discovery of the first pulsar was announced from Cambridge, England. The initial report was quickly followed by the detection of many more pulsars; about 40 are now known. At first two theories were proposed to explain them. Because periods of pulsation are all very short—the longest is 3.7 seconds—it was clear that they must come from very small objects that are either pulsating or rotating. The only stars conceivably small enough were white dwarfs (very dense stars near the end of their lives with no inner sources of nuclear fuel: a matchboxful of their matter would weigh several tons) or neutron stars (still denser objects: a dime at their density would weigh more than two million tons). Both ideas were explored, but it became clear that if very short period pulsars were found, rotating neutron stars would be the only possible explanation based on well-established stellar models. In the latter part of 1968, a group of astronomers at the National Radio Astronomy Observatory found two pulsars close to the Crab Nebula. Once accurate positions were determined, it was found that one of these pulsars, NP 0532, lay inside the Crab, while the other, NP 0527, lay outside it about a degree away in the sky. The pulsar NP 0532 was found to have the shortest known period of 0.03309014 seconds—pulsing about 30 times a second. This period was so short that it had to be concluded that this pulsar—and presumably the others—was a rotating neutron star. Strangely enough, the pulsar outside the Crab has the longest known period of 3.745491 seconds.

When the first pulsar, which has nothing to do with the Crab, was found, attempts were made to see whether it emitted light signals with the same period as the radio signals. Despite theoreticians' thoughts that this was highly unlikely, serious efforts were made to look for the effect, and early work suggested that perhaps such light pulses were being emitted. But it was soon found that these results were spurious.

When the radio pulsar was discovered in the Crab, three young astronomers at the University of Arizona—Cocke, Disney, and Taylor—attempted to see if they could detect light pulses with the same period as the radio pulses. They succeeded immediately, and within a few days other groups working at the McDonald and Kitt Peak National Observatories confirmed their results. The latter group, and Miller and Wampler at the Lick Observatory, were able to show that the object emitting the light pulses, and presumably the radio pulses as well, was the star that, thirty years before, Baade and Minkowski had thought was probably the remnant of the supernova. Of course they had thought that it was a comparatively normal star, but had they looked at it with a time resolution of one-thirtieth of a second or better, they would have seen that its light was coming to us in sharp pulses.

By 1969 it was established that a rapidly rotating neutron star in the Crab is emitting tremendously powerful pulses of radio and optical emission like a gigantic rotating lighthouse beam. But this was not the end of the discoveries concerning the Crab pulsar. Another finding was that X-ray pulses are also being emitted with the same period, so that most of the energy is emitted in the X-ray pulses. The Crab pulsar is, so far, unique in that it does emit pulses of light and X-rays as well as radio pulses.

With these discoveries the next step was clear. The pulsar must be the energy source for the Crab, so that not only is it emitting radiation directly by the synchrotron process, but it is also ejecting large numbers of charged particles from its surface, and these are being accelerated in the very strong magnetic fields that theoreticians believe must be present in neutron stars. These fields are colossal. Elementary calculations make us believe that the surface fields in such a star have strengths of hundreds of billions of gauss, as compared with about half a gauss on the earth, one or two gauss on the surface of the sun, and thousands of gauss in sunspots where flare activity or magnetic storms are generated. Thus, the energy generator in the Crab is a small (a diameter of only a few miles), incredibly dense star (its density is about the same as that of the *nuclei* of atoms), with a very strong magnetic field, and it is rotating about 30 times a second. Thus it is a gigantic rotating magnet. Many people have studied it theoretically to try to understand how it is able to accelerate particles, and while many details are not understood, most agree that rapid acceleration is to be expected. The rotation period of the pulsar is getting longer, so it is clear that it is slowing down, and the rotational energy being dissipated is the energy that is maintaining the Crab.

No one has yet been able to explain why the radiation is pulsed, that is, why it is generated in such a way that it is emitted only in a small, cone-shaped angle from the surface of the neutron star. The radiation cannot be emitted uniformly from the surface; if it were, the star would not emit pulsed signals. This raises another interesting question. If we see pulsars only when they are rotating in such a way that the signals they emit are pointing toward us once each revolution, how many more pulsars are there that we cannot see? Could there indeed be more than one rotating neutron star in the Crab?

There is perhaps some evidence that there is more than one center of activity in the Crab, although the evidence is only tentative. Several years ago, before the discovery of the pulsars, the Cambridge radio astronomers discovered a small, intense, steady source of radio emission in the Crab, with a size no bigger than the solar system. Because it is weak compared with the whole of the radio emission from the Crab, its position is not well determined, and many people believe that it is centered on the pulsar. But this may not be true, and there may thus be at least two condensed objects in the Crab. Other evidence may point in the same direction. I mentioned earlier that the Crab is emitting X-rays from a region perhaps two light-years across. And I noted that if all of the high-energy electrons that radiate these X-rays were accelerated in the known pulsar, it is very difficult to see how they could travel out so far from the pulsar and still have enough energy to emit X-rays at distances of one light-year or more from the center. This difficulty can be avoided if we suppose that in reality the X-rays come from several condensed objects spread throughout this region; in other words, that there are a number of radiating neutron stars in the Crab, and not just the one that we see as the pulsar. X-ray astronomers can test this idea. If it is correct, then when they are able to look at the Crab with high resolution, it will appear to be made up of a number of small, bright regions. On the other hand, if it appears to be a smooth, extended source, then we must conclude that despite the difficulties the pulsar at the center is able somehow to accelerate all of the particles that are now spread throughout the Crab.

There is one final topic of some interest. Do we really understand how a neutron star is left behind in a supernova explosion? When a star has evolved so that it has no nuclear energy sources left in the center, it collapses, and a number of theories have been suggested to explain why the outer part will be ejected. But general relativity tells us that only stars or parts of stars with masses less than a critical value close to the mass of the sun, can withstand gravitational collapse and turn into stable neutron stars. If the central part of a star going through this process has a mass greater than the critical mass, the theory tells us that it will collapse indefinitely and become what relativists have called a "black hole," effectively cutting itself off from the universe except for the effect of its gravitational field.

Thus it is not obvious at present why the supernova that produced the Crab left behind just one neutron star and not a more massive black hole. One possibility is that the part of the star that collapsed did have a mass much greater than the critical value, but that it was spinning so rapidly that it broke up into a number of pieces, each of them with a small enough mass to form a stable neutron star. This would fit the suggestion that there are perhaps a number of condensed objects in the Crab, but only one that we see to emit pulses.

I have attempted to tell the story of the Crab Nebula as astronomers have developed it over the last several hundred years. Now in 1970 we believe that many of its mysteries are at least superficially understood, but it is still of immense interest. This summer the International Astronomical Union, the official international association of astronomers, held a whole symposium on the Crab at the Nuffield Radio Observatories at Jodrell Bank, which brought together optical, radio, and X-ray astronomers, as well as theoreticians who work in almost all branches of astrophysics. It is hard to predict what will happen next.

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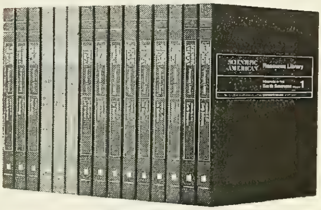

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Peoples of Indochina

Continued from page 53

One of Thailand's major problems, that of unrest in the northeastern region, often has been seen as a result of Lao predominance in that region. This view is misleading. Laos has a limited appeal for the Lao of Thailand because of their successful integration into Thai society. However, the Thai do face serious problems of ethnic dissent among some upland groups in the north and the Malay in the south. The specter of a strong, unified, and hostile Vietnam haunts Thailand. Moreover, the Thai fear that Laos and Cambodia, which they consider within their sphere of influence, may be lost permanently to Vietnam.

In Vietnam, aside from the problems of upland-lowland relations, the cleavages fall mainly along ideological lines. Nonetheless, cultural variations between northerners and southerners and religious differences between Catholics, Buddhists, and other sects have complicated efforts to unify Vietnam. Despite their differences on how Vietnam should be ruled, Vietnamese leaders on both sides of the 17th parallel strongly favor a resurrected Indochina in which the Vietnamese would dominate.

In the present war ethnic and cultural factors have assumed additional significance. Support given by outside powers has enhanced the importance of selected groups in the region. Tribal peoples with international connections are wooed by many parties. Russian and Chinese arms have been brought to Thailand by some Miao tribes, while across the border in Laos, relatives of these same Miao are being trained by American Special Forces.

The opium trade engaged in by a number of groups that have come to Laos and Thailand from South China helps to underwrite the actions of belligerents on both sides. In Laos, it is reported that planes displaying poppy designs on the underside of their wings are never shot at. Southeast Asian Christians have particularly attracted Western support. Missionaries among various tribal groups have worked with civic action units of the American military and with American aid personnel to promote the interest of their followers. The Chinese hav promoted a movement of unit among all Thai-speaking peopl with leadership drawn from Tha groups living in South China. An the United States has recently give credence to South Vietnam's clai to interfere in the internal affai of Cambodia by undertaking joi American–South Vietnamese oper ations in that beleaguered countr

In Mae Sariang, tribal people and lowlanders have lived for man centuries in a symbiotic relationship. New adjustments were mad as the ethnic composition shifted Such adjustments were not withou pain, but they led to a pragmati harmony between the many faction until the Westerners came.

The first Westerners were th representatives of the Bombay-Burmah Teak Company. They employed Karen tribals to whom the spoke in Burmese rather than Thai The gap between the Karen an Thai in Mae Sariang began to widen. Before World War II, Bombay Burmah Teak Company left an was replaced by a Thai-owned tea company. Today the Karen worker in the teak company speak in Tha to their employers, and one sourc of confusion and mistrust in th community has been eliminated b the inhabitants.

Western missionaries also came to Mae Sariang. They worked primarily among the tribal peoples. Today the small educated minority from these tribes is almost exclusively Christian. They strongly assert their tribal identity because to them, being Thai is being Buddhist. The Christian community among the tribal peoples in Mae Sariang is still growing, and the gap between the Thai and the tribals is growing, too.

Although the British and French, like the Bombay-Burmah Teak Company in Mae Sariang, have left Southeast Asia, the Americans, like the missionaries in Mae Sariang, are still there. The gaps between various ethnic groups, various cultures, and various nationalities continue to grow, and the adjustments that will have to be made after the Americans are gone will be that much more painful. ■

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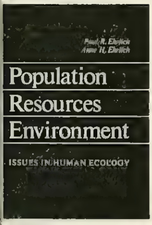

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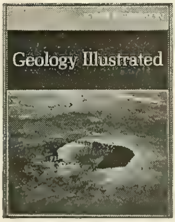

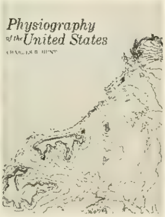

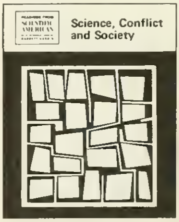

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The Cliché of the Killer

Continued from page 28

In the spring of 1968, fishermen of Pender Harbour, British Columbia, perfected a method of netting killers inside a narrow inlet. They captured eight that year. Pender Harbour has proved to be an ideal place to hold killer whales. It is sheltered, clean, and close to a fish dock where food for the whales can be easily obtained. Since 1968 the Vancouver Public Aquarium has maintained a research station there. Scientists come throughout the year to study killer whales under semi-wild conditions. The animals often "talk" to their companions outside the fence.

At one time or another, killer whales have been exhibited in at least seventeen oceanariums: in Australia (1), Canada (3), England (2), France (1), the Netherlands (1), and the United States (9).

The killer whale is the largest marine mammal ever held in captivity and is therefore of interest to scientists who plot animal functions on the so-called shrew-to-elephant curve, or the curve illustrating the physiology of mammals from the smallest in weight to the largest. Actually, a bat may be the smallest mammal and the blue whale is certainly the largest. For example: a shrew weighing less than an ounce will eat food equal to 150 percent of its body weight per day, while a killer whale the size of Namu, weighing 7,520 pounds, will eat only 5 percent.

Other zoologists study the killer whale's adaptations to swimming and diving. A killer was found tangled in a submarine cable off Vancouver Island at a depth of 3,378 feet. A killer in Puget Sound, carrying a harpoon, line, and floats, remained under water for 21 minutes.

The Vancouver Public Aquarium has a splendid female killer named Skana. I recently watched as a team of physiologists put a modified "plumber's friend," or suction cup, over her blowhole to collect respiratory gases. Others took blood samples from her tail for study of the oxygen content. Still others took electrocardiograms. Skana, who has known only kindness in captivity, was remarkably patient during the four-hour probing of her life processes. She had learned to accept the periodic "letting down of Skana," when her pool is drained and scrubbed and she herself is stranded on a foam rubber cushion, surrounded by eager investigators.

I will never forget that scene as the water slowly drained away and six men in black rubber suits stood on the floor of the pool beside the black-and-white beast. By gently tugging her tail or flipper now and then they persuaded her to settle on the cushion, like a mother hen on the nest. Once, in what might have been apprehension, she jerked her tail and baptised a man by total immersion. Had she released the full power of that tail, she would have broken his neck.

On an ordinary day when Skana is loafing in her pool, she may be visited by a zoologist intent on listening to the songs she sings underwater and out. Her clicks are useful for echolocation; her whistles and squeaks for communication with the killer whales of the open sea who now live only in her memory.

It took more than 1,600 trials to test the sharpness of Skana's vision underwater. Surprisingly, her eyesight is equal to that of a cat in air. She occasionally slips into periods of deep sleep like that of men and other terrestrial mammals. In scientific language, one expert has written that Skana gives off "low intensity aperiodic vocalizations" during sleep. (That is to say, she snores.)

A spin-off result of holding killer whales in captivity is new light on their husbandry, or care. How does one wean a toothless, 800-pound suckling baby? In one report, a veterinarian force-fed a baby whale three times daily, using a formula made up of one gallon of fresh whipping cream mixed with human baby food, some fish, warm water, and vitamins—until the animal began eating independently.

And towering above the scientific value of captive killer whales is the knowledge that millions of people are now being led to a new experience—a combination of entertainment and education—that surely leaves them with a warmer and closer feeling for animals.

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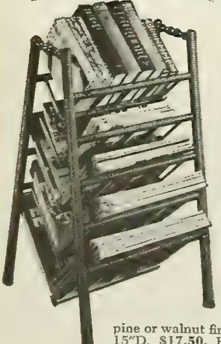

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however, that the pursuit, capture, and even killing of this splendid species of wildlife is unregulated in the United States. Killer whales belong to all of us, yet any amateur with a spear, gun, or net can now legally chase them.

I recall one Sunday when a killer whale created the worst traffic jam in the history of the Columbia River Bridge near Portland. A female killer had wandered 110 miles up the river from the ocean. She sported for several days off Jantzen Beach, where thousands came to see her from the shore. One night, she was harpooned and killed by two men, the Lessard brothers. Arrested for taking a "fish" with illegal tackle, they were later released when the difference between a whale and a fish was made clear to the prosecutor.

Several years ago, an editorial on Seattle's radio station KIRO announced that "the real purpose of the whale-catching [in Puget Sound] is abundantly clear. It's to make music on the cash register, whether as entertainment . . . or to sell whales to other marine shows." As I write today, the price of a live killer whale is about $20.000.

In closing this narrative of the gentle whale and what it has done for men, I suggest what men can do for the whale. I endorse the enactment of a law for the regulation of killer whale hunting in Washington State. In Canada, one needs a federal permit to hunt whales within the twelve-mile limit, and additional regulations are being drafted.

In January, 1969, a bill providing for the management of killer whales was introduced in the Washington legislature. Although it was shelved for study, I am encouraged to believe that it may pass in 1971. Why should the killer whale be brought into a wildlife management scheme? I suggest the following reasons:

The whale populations should be monitored to insure against overkilling. A hunting license would bring revenue to support population research.

There have been unintended cruelties in the hunting of whales. Shrouded in secrecy, at least six whales have been killed by Seattle showmen. One disappeared when a drug syringe was fired into its back from a helicopter. But zoologists know that you can't immobilize a marine mammal in the water; it will drown. Another whale, a five-ton bull, died of infection. The hunters had thrust a 16-inch harpoon into its back, and to the harpoon had tied a 1,000-foot line with floats. Their intention had been to mark the largest male of a family—the group leader, or "pod bull"—so that they could track the family and eventually surround it with nets. A whale law would allow an observer with no financial interest in the operations to be present during the chasing and handling of whales.

Hunting should be banned from waters where many people now thrill at the sight of whales in the wild and free. At present there are more than 186,000 pleasure boats operating in Puget Sound. The thought has often been expressed that persistent hunting will drive the whales away from their usual haunts. I have enough respect for the intelligence and social instinct of *Orcinus* to believe that this may be so. A whale law would establish no-hunting preserves in scenic waterways and within sight of urbanized shores.

Whether the whales of Washington State should be managed at the state or federal level is not altogether clear. Little is known about the movements of any American dolphin, porpoise, or small whale, with the exception of the Alaskan beluga, or white whale. One could argue that by its very nature a marine mammal is free to travel across state and national boundaries and is thus a proper subject for national and international regulation. In my opinion, however, it would be more practical to regard as resident species those that are commonly seen feeding—and perhaps even breeding—within state waters. Rather than quibble about jurisdiction, we should take the first step: regulate by license the hunting, holding, and killing of killer whales in Washington State.

To those who believe that nothing is worth doing unless we can beat the Communists at it. I offer no encouragement. The Russians have already banned the hunting of dolphins in the Black and Azov seas for a ten-year period that started in 1966. ■

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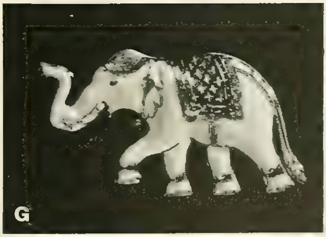
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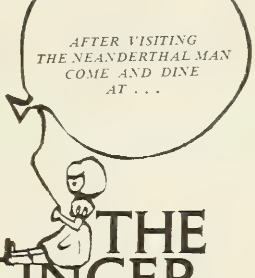
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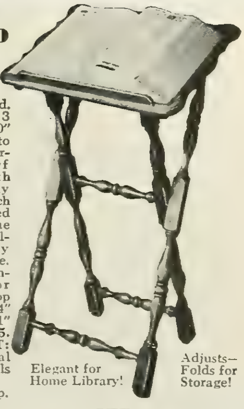

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Wit, Wisdom, & Woe

Continued from page 24

it"—in other words—you *can* fight City Hall.

New York, New York

I now refuse to cooperate with police, serve on juries, show respect for public officials, and pay local or state taxes on which I can cheat. I trust nobody connected with the law: judges, lawyers, etc. All because I was kidnaped by the local Gestapo for protesting noise pollution to the very public officials creating the din. I was put in jeopardy; subjected to slander, vilification, obscenity, and intimidation by court officers; sold into frame-ups by shysters I hired to represent me; subjected to prejudice by courts; and once beaten by a cop. I have asked for justice everywhere, but it seems, you can't fight City Hall. Mostly, I have no competent lawyer and can't find one.

Bridgeport, Connecticut

I tried in 1936 to get a good sewer system but was defeated by two votes. Now it has been done, so in the end we win, I believe. Now, 34 years later, it is passed. Hurray!

Harrisburg, Pennsylvania

Though I am blind, association with ecology groups has given me greater incentive to go on, and association with the people in them has given me new values.

Bell, California

There has been considerable reduction in what is considered "normal" social activity. I find the animals much more interesting than most people.

Laurel, Maryland

I shout at slobs that I catch littering and polluting. (I'd shoot them if it were legal.)

Santa Monica, California

I no longer use any colored paper and I waste a lot less and think a lot more when I do. I lecture all the time. I keep dreaming of bombing Con Ed.

Bloomfield Hills, Michigan

My profession is law. I have chosen to exclude myself from professional employment involving causes which are antithetical to the goals of the movement.

Los Angeles, California

I boycott products that are high waste producers. We've given up hunting and fishing.

Longview, Washington

After obtaining a B.S. in engineering, I have abandoned my intention of seeking my M.S. in thermodynamics. I have decided on an extra year of undergraduate work in biology and graduate work in ecology and/or environmental engineering.

Los Angeles, California

I'm starving because I left a good job to return to college and get a degree in environmental health. I quit using DDT and other sprays except the unstable kinds. Quit smoking and burning trash outside. Quit hunting.

Kingsport, Tennessee

I am an immigrant and a successful artist. But at the age of 37 I enrolled at Hunter College School of General Studies to study biology and psychology. I intend to become a biopsychologist and spend the second half of my life working on environmental and behavioral problems. I have no children (I am sterilized) and plan to move out of New York City to a more natural environment (Midwest?). We have no car, don't buy "no return" items, and have convinced my laundry service not to use plastic wrapping. I never buy fur coats. I keep plants for pets. And it seems that many friends of mine are following the example.

New York, New York

I resigned from a $12,000 position as a research chemist engineer to work for next to nothing in the movement.

New Orleans, Louisiana

Upon retirement within a few months, I plan on spending all or near full time with or without pay on antipollution work, believing that pollution can best be eliminated at its source.

Livermore, California

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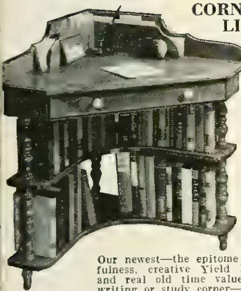

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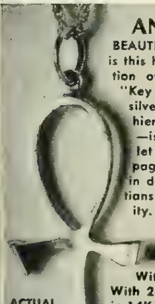

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Our own plan is to develop a small area of watershed land (15 acres) into a game protection area within a heavy farming community, by reforesting and planning food and shelter areas. We hope we can donate this area—to be retained in this state—to an agency which will insure its safety as such.

Littlestown, Pennsylvania

For 39 years I have lived in a forest that in late years has become a real estate development dream. I have resisted successfully. If I don't die soon I will have trouble with taxes.

Houston, Texas

I own and protect a 3,000-acre mountain cove (with farm in bottomlands) against hunters and despoilers—and the usual careless damned fools.

Mill Spring, North Carolina

After careful evaluation of the total situation and the complete frustration involved with attempting to change individual man—let alone society—I slowly became a so-called hippie. Last October I closed my professional office, moved to a reasonable degree of country, and became a student of life.

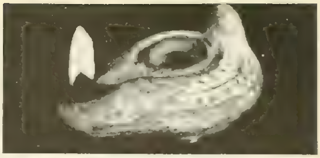
As I watch this society destroy itself, minority groups within it, other countries and their people, and the environment of the entire world, I feel the total frustration of attempting to effect a meaningful change by nonviolent means—the only meaningful answer seems to be to stop supporting the system. This is why I stopped working, paying taxes, and buying things I do not absolutely need. I also use feet or a bicycle instead of a car.

Point Reyes Station, California

I have chosen a life style of subsistence farming, without use of electricity, automobiles, phones, etc., —communal, in Maine.

Richmond, Indiana

I live communally in an ecologically concerned community (Synanon). I try to minimize use of unecological products such as plastics, coated papers, detergents, etc. I have stopped polluting my own body with caffeine and chemicals as



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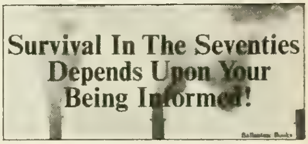

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a personal demonstration.

Santa Monica, California

My conservation practices have intensified. However, most significant changes in my life style are attributable to my life as a nudist (10 years).

Greenville, North Carolina

Studying and learning the parameters of the environmental problem begins to consume most of my leisure time; I have cast off my GNP-oriented consumer attitudes; socially I seem to be suffering the results of a kind of xenophobia—in my own country!

New York, New York

I now bring up the problems of pollution, etc., to all clients for whom it is relevant (I am in the advertising business). I urge them not to treat it as a public relations problem but to do something about it.

Englewood, New Jersey

We now try to buy only returnable bottles and detergents that break down in water. My wife has decided not to purchase a fur coat, which prior to this was one of her main objects to acquire.

Monticello, New York

I now question the motives of conservation writers and adherents.

Menlo Park, California

I will not buy anything made of sealskin, alligator, or from the fur of wild animals. I try to buy soaps, which add the least pollution. I am most conscious about littering, and have fought the use of DDT since I had DDT poisoning some years ago.

New York, New York

I have completely given up using detergents, even for dishwashing. Save water; save electricity. For the past 4 years I have kept local mosquito control sprayers with their damned DDT off my 6-acre place.

Leonardtown, Maryland

The ecology movement has affected me to the extent that where before I would think nothing of littering, I now never litter, and pick up litter I see on the street. I also speak with people who wear ecology buttons and still litter—the damn hypocrites!

West Hurley, New York

Ecoconversions

In the last few years I have had a gradual broadening of my outlook. I have changed from "leave well enough alone" to "let's get the facts and see what we can do."

Bronx, New York

My life has been changing in the last year and conservation and ecology are affected, but I have been close to nature all my life. I have become a vegetarian and practice yoga; I have found more inner peace and awareness of God.

Spruce Pine, North Carolina

I am much more aware and concerned for my environment. I was once shy, but am now constantly talking to people young and old about our problems. For once, I be came involved in something I believe in!

Westbrook, Connecticu

It changed me from an overly po lite, mild-mannered, non-joining in trovert, to a brash, aggressive "nothing is too big to tackle" ex trovert. It also made me realize tha good government is up to me.

New York, New Yor

I was a happy bird watcher. No I am an unhappy conservationist. am interested in very little excep nature, conservation of what wi derness is left, preservation of wil life, and a clean and healthy env ronment. I write hundreds of letter

Beaumont, Tex

Involvement has been minima but for the first time in my life have written letters to governme officials, namely Secretary Hick about the Everglades. I have wri ten for a list of detergents low phosphates, and am determined use as little of such detergents possible. I have shortened my skir so as not to be mistaken for one the dismal, silent majority. My e forts have been small and person

Polk, Pennsylvan

I have gone from the typical gray flannel suit city-type to an informal, longer hair "outdoor" type.

New York, New York

Awareness combined with anger has caused me to involve myself through letter writing and phone calls to industrial polluters—we are not group joiners, but the crisis may force us to be.

Allston, Massachusetts

The Automobile

I am doing without as many man-made products as possible. I do not own a car and am violently opposed to the automobile and all it has done to our society and our morality as a people.

Washington, D. C.

We are bad for the economy—with relish. I drive a seven-year-old, perfectly tuned, four-cylinder car (31 miles/gallon).

Berkeley, California

I now ride a bike to school. I haven't been in a car since April 3 (59 days).

New York, New York

I am anxiously waiting for the practical electric car, one that can go more than 50 miles before being "plugged in."

Moosup, Connecticut

Every day I wish for the downfall of the combustion engine.

Woodland Hills, California

Economic System

I eat mainly organic foods, avoid driving, buy only secondhand clothes and furniture, and generally try to avoid supporting the U.S. economic system.

East Hartland, Connecticut

Involvement in ecology is an involvement in life and the will to live without the threat of imminent destruction. Involvement in ecology is involvement in messy politics and a need for revolutionary changes in U.S. economic and social life.

Pacific Palisades, California

The vast majority of Americans believe very much in our present private enterprise system which has given us the greatest good for the greatest number of people in history. I feel that any publication which draws erroneous associations regarding our system will eventually harm itself.

Los Angeles, California

I now prefer to be in the mountains rather than the cities; I no longer believe in progress and the American Dream.

Chicago, Illinois

To us, it is not a matter of this economic system being good and that one being bad, but rather that man makes an economic system either good or bad in his application of it.

Salford, Pennsylvania

We are totally pessimistic for the long range. This society is one of greed and selfishness, and by the time it hits the pocketbooks of the greedmongers it will be too late.

Canton, Missouri

I am in my sixties and perhaps overly pessimistic. I do not think man is going to make it.

The Third World and socialist countries feel that antipollution devices are too expensive and will impede their construction programs.

The capitalist countries put immediate gain above ultimate good. I receive all sorts of business trade journals. They agree that some antipollution devices will become mandatory, but advise "play it cool, Jack," just do the bare mininum to get by.

Let's not laugh at the dinosaur. He lasted, was it one hundred or two hundred million years? We have been here—two million? If man survives for two more centuries it will be unforeseen by me.

Los Angeles, California

The great drawback in all antipollution is that it costs money to avoid pollution—and people aren't willing to pay more for a product that is made without pollution than they would for the same product made cheaper by easy disposal of the pollutant.

Glens Falls, New York

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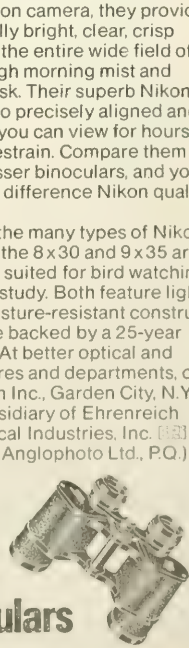

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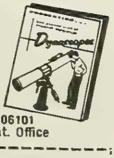

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The problem of pollution will be solved by those agencies and individuals who are able to do things differently than they presently are and by individuals who are willing to pay the cost of more expensive services and higher taxes. Some of the worst polluters are municipalities, and the importance of the latter should not be overlooked.

Scott, Mississippi

Population Problem

I believe that *all* our present problems are directly or indirectly based on the population problem!

New York, New York

I won't have more than 2 kids (watch me have triplets). I kind of think now that it's morally wrong.

New Haven, Connecticut

Even though I am a working mother we have eliminated the use of paper napkins, plates, cups, towels, tissues. As a Catholic family we have had a rift with the church over birth control. I quit a job working for an oil company.

San Diego, California

A serious study of the population crisis led my wife and me to resolve to have only 2 children even though I never got the girl that I wanted.

San Diego, California

My concern with overpopulation has hardened my attitude toward death, causing me to lose interest in life-saving medical research. I also feel there is no cure for human misery and inequity as long as overpopulation exists.

Danbury, Connecticut

I am choosing sterilization over any other form of birth control. I have undertaken conservative gardening practices. An increased awareness of conservation in all daily tasks—aimed at lessening all kinds of pollution. I bought GM stock to give proxy to Nader. I am considering giving up my automobile.

Binghamton, New York

I drive a 4-cylinder auto. I had a vasectomy to prevent having more children. I purchase as much food and beverages as possible in returnable packaging. I have a tendency to talk too much.

Osceola, Missouri

I will not have children primarily because population is the direct cause of environmental pollution.

Anaheim, California

Beautiful People

I am less concerned with material things. I have feelings of exhilaration at times because so many good, beautiful people are backing the movement.

Bonners Ferry, Idaho

Can't we think, plan, discuss, or act without letting our hair grow and carrying a placard?

Studio City, California

Our duty is to the earth first, but to get there we must free ourselves from the oppressors! Since time is short, moderate and compromising measures do not change situations. Seize the Time, Off the Slime, Free Huey, The Panthers, Puerto Rico. Free Amerikkka. Liberation of all Third World People. Give the Earth back to Nature!!! Free the Anglo-Saxon from his binding puritanical beliefs. Learn to breathe, dance and sing.

New York, New York

I am not in any trouble-making movement and as a taxpayer I am tired of anarchy in this country. Nought is to be gained by it. If presidents following Lincoln had sent all Negroes back to Africa as Lincoln intended, such rackets wouldn't exist today. Don't mess with strife—I served my country loyally and am enjoying my retirement writing a historical novel.

Los Angeles, California

I do not join organizations or follow leaders—I lean toward anarchy (classical).

Chicago, Illinois

own and work in our own store l talk to the public if the occa-n presents itself. I do not ap-ove of radical groups. Each per-ı can influence another to think ecology if he will not use the rrible radical methods. The radi-s are the filthy pollutors. Also, I ieve, Communists.

Harrisburg, Illinois

Concern with population/pollu-n/environment tends to make one evolutionary. I now devote more ıe, more thought, more money to se organizations than I did a ar ago.

La Grange, Illinois

On the basis of considerable ex-rience (as a university professor) th activist students I caution that ology as such does not really in-est the revolutionary but is being ed as a convenient cause. The ology movement can unite the untry; to associate it with politi-l revolution would be disastrous.

Collinsville, Oklahoma

Mine is a life style of change. I a traveler. A yoga student. A otographer. A bum (I don't work r pay, but for life). A writer. A rate student. A farmer. A lover of e (where nature is, so I am also). l these are part of loving life and ture.

No address

Getting Away

Have substituted a bicycle for a ır. Am moving to New Guinea in ctober.

Downey, California

We prepare much more fresh od rather than buy tins, reuse all astic; have decided that so little ın be done in the United States at we are emigrating to New Zea-nd.

Berkeley, California

I am doing without many con-enient items. Decided to have only children. Use one small car. Also ave up in despair and am moving Australia.

Jacksonville, Florida

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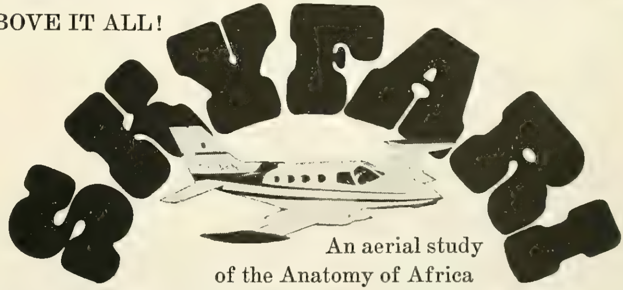

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Springfield, Vermont

Ecophilosophy

What is urgently needed is a revolution in values, and no sabotage or bombings will bring this about.

Wanwatosa, Wisconsin

I am less interested in material gain, physically more active, philosophically more active; educational and intellectual goals have changed, I spend more time off my tail and out in the field.

Califan, New Jersey

Maintain ascetic ethic with hedonistic violations.

Vancouver, Washington

I believe strongly in the oneness of all creation, and in the responsibility of each to all others; human, animal, plant, and inanimate.

Reno, Nevada

I have become more aware that I am as responsible as most other individuals for the causes of pollution. It has given me a much broader perspective of my vocation as clergyman.

Grafton, Virginia

I have altered my goals in life, have become less materialistic, have rejected Christianity and all religions; I am selling my large home to live in a smaller and more modest one.

Chester, New Jersey

I ride a bicycle whenever possible. I do not use air conditioning. I restrict my use of electricity. I pray regularly for the sake of the world. I have stopped smoking. I use organic foods as much as pos-

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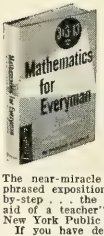

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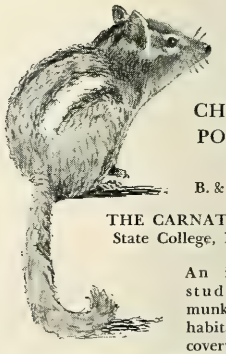

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sible. I restrict my use of pesticides, plastics, nonreturnable bottles, etc. I petition my government for redress of grievances. I contribute to ecology organizations.

I pray a lot for the world.

Philadelphia, Pennsylvania

The Next Generation

I am only twelve but I have attempted to answer your questionnaire. It's hard to get yourself involved with grownups but among my classmates, my friends and I have started an anti-DDT campaign.

Poughkeepsie, New York

I'm observant in watching people for littering or polluting. I don't let my brothers shoot any rabbits or birds. I scare them away.

Chicago, Illinois

I had once tried but failed to get involved with a group. Like everything else, I was more or less ruled out by the caste system. I'm only in the fifth grade and they were in the ninth.

Elizabeth, New Jersey

I am only a high school student, currently in the 11th grade, but I have been made aware of the crisis facing us through publications such as Natural History. Unfortunately, not all young people have access to such, or the interest.

What I'm getting at is this: more should be done to interest young people in ecology and conservation. Classes should center around these important themes, and student conservation groups should be encouraged. Many adults I have spoken to about this critical issue have the same idea: "Well, let these student pinkos do it; I'll be out of it soon enough, anyway." And kids say, "Let the establishment plant their cherry trees and harp about pollution." So we're not getting anywhere with the ecological movement due to apathy and indifference on both sides.

That is why I say, please, try to get through to young people. And the older generation, too. No telling how long any of us will be here.

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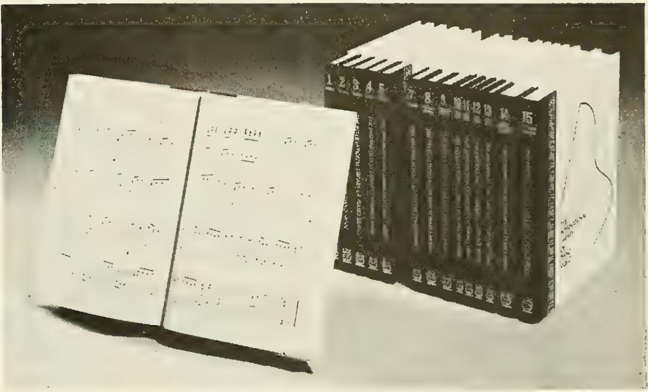

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The Birds of the Open Sea

by Robert Cushman Murphy

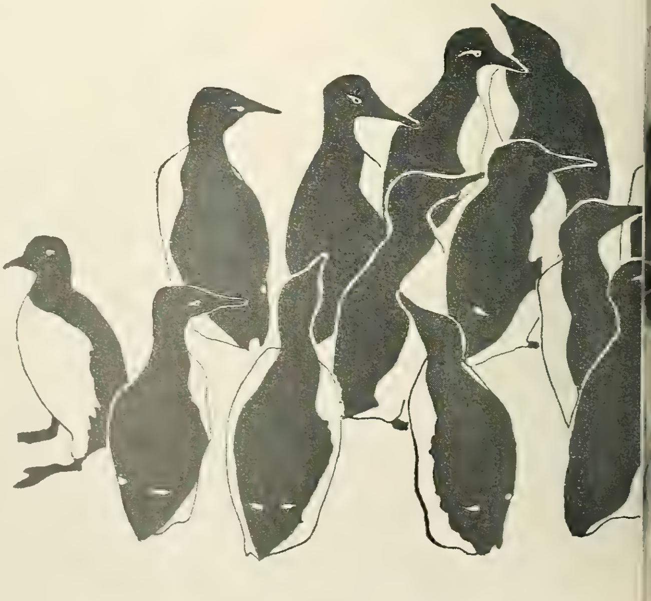
THE STORM PETREL AND THE OWL OF ATHENA, by Louis J. Halle. *Princeton University Press, $7.50; 268 pp., illus.*

Louis J. Halle, highly regarded for earlier, sensitive works such as *Spring in Washington*, *Sedge*, and *Men and Nations*, has now written this volume of oddly diverse title. In the preface he states that "Parts One and Two, although superficially different, tend to repeat each other in their underlying thought like a theme and variations in music." Some readers may feel this harmony clearly; others will disclaim any such fundamental cohesion, despite the author's attempt to effect a linkage of the parts by means of epilogues. But, whether it is read as one book or two, all will find his text rewarding.

Mr. Halle is a diplomat with ornithological leanings. Throughout long years he tracked "local birds over field and meadow, through woods and swamps," while sea fowl remained mostly in his imagination. Finally, in order to become familiar with the latter also, he betook himself and his family to one of the world's great centers of oceanic birds—the Shetland Islands. There, for the first time, he resided cheek by jowl among storm petrels, fulmars, gannets, cormorants, auks and their relatives, gulls, skuas—large and small—terns, phalaropes, waders, loons, and eiders, with side glances at such ubiquitous immigrants as rock doves, starlings, and house sparrows. His observations are critically sound, his enjoyment keen, and his account correspondingly refreshing. In addition, he proves himself a masterly illustrator. His drawings are of the simplest sort, but they ring true of the birds in tone and stance, and his seascapes suggest admirably the misty-moisty atmosphere of the Scottish isles.

On Mousa, no longer inhabited by man, the mysterious storm petrels come only after dark to their hidden homes in the massive, unmortared stone walls of a broch, or round tower, built by unknown aborigines. The tower itself has been superbly pictured by Halle's pencil, and likewise the tiny petrel seeking its entrance chink against the vertical wall. His portraits of fulmars in the air, or on the nest all set to shoot stomach oil at an intruder, are equally convincing, as are his man-attacking skuas, murres, red-throated loons, perky puffin, black guillemots, and others. Three cheers for a writer who can give us such perfect alfresco likenesses of his birds.

The fulmar is the most numerous of Shetland birds and Halle offers an entertaining story of its behavior and life history. As a species, this once exclusively Arctic petrel has in recent times undergone a population explosion without known precedent. This has brought vast numbers down into temperate seas and has ringed with nesting colonies virtually the whole coast of the British Isles and even the channel cliffs of France. Halle follows Fisher in the orthodox explanation that the expansion of the fulmar is due to the increased food supply resulting from whaling and trawling operations. But a quite different hypothesis has been advanced by the Danish ornithologist Salomonsen. This authority emphasizes that there has been no perceptible enlargement of the population from Iceland northward. The entire increase appears to stem from the island of St. Kilda. Salomonsen therefore postulates a mutation in the St. Kilda population that has widened the climatic and feeding tolerances of the affected fulmars, and which repre-



ents, indeed, an incipience of speci-
tion. The fulmars, in Salomonsen's
iew, have not moved down from the
rctic. Rather, the birds of a limited
rea have acquired adaptations that
nable them to take advantage of a
reviously unexploited environmental
iche.

As Halle writes elsewhere in his
ook, the search for truth is always
ubversive of orthodoxy and fashion
like!

And so, with chapters that deal
ith gulls, skuas, the extinct great
uk and its nemesis, man, the gannet,
nd wading birds, he proceeds with
is intelligent discussion of the pro-
esses of evolution. His epilogue to
'art One then points out the utterly
ifferent view of the cosmos that mod-
rn man holds, or should hold, from
he one presented in the Book of Genesis, where the earth was the central point of the universe and man's approved function was "dominion" over all other forms of life. With what disasters has that attitude brought us face to face.

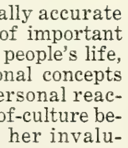
But here the author begins to develop as well his teleological faith, where he is on much less certain ground. Birds sing, he writes truthfully, "to inform other individuals belonging to their species that they are on their own territory, which they will defend. But this is as readily achieved by those species that simply croak as by the Nightingale, which is moved to engage in a performance at once elaborate, inventive, and as beautiful in its way as a sonata by Mozart." Here we see Halle continuing the argument of Delamain in *Pourquois les oiseaux chantent.* Neither author, however, gives us a hint as to why the "croakers," which have enjoyed the same eons of time as the nightingale to improve their performance, have so signally failed.

Part Two of this book comprises a series of previously published essays, in which the author writes at random. It is by no means all ornithology, and yet more than 250 species of birds receive at least mention. It has the thousand strands of a broom, whereas Part One seemed as single-pointed as a bayonet. Individually, the chapters carry us far and wide—from Geneva, where Halle now resides, to the Isles of Greece and Socrates, and to the pampas of Argentina and W. H. Hudson. The author's ideas of design and purpose in life are further extended. Here, as always, readers will enjoy the style and stimulation of an accomplished pen.

The factual errors in Halle's book are few, and chiefly due to forgetfulness or oversight. "Petrel," despite the persistence of an a posteriori definition, has nothing to do with St. Peter's walking on water. The spelling of the word in early English was "pitteral," and seems to refer to the pitter-patter of the birds on the surface of the ocean. Adult goshawks have red, not yellow, eyes. The Dominican gull, or kelp gull, of the Southern Hemisphere is almost certainly a herring gull that has acquired a black mantle (or perhaps the transposition went the other way). Most surprising of the author's lapses is his statement that the Pelecaniformes are "unique among seabirds in being altricial rather than praecocial," confined to the nest instead of running about as chicks. The petrel-albatross order (Procellariiformes) is made up exclusively of altricial birds, which have an even longer period of helpless infancy than the pelicans and their kin.

One final criticism will illustrate the speed of scientific discovery, with which a devotee can scarcely keep up in his own field. Halle writes: "The notion that they [Arctic terns] do inherit knowledge that their ancestors have learned surpasses the bounds of genetic orthodoxy." Does it? How scientists of a mere twenty years ago would have laughed at the following quotation from Lockley's *Animal Navigation* (1967). Yet today it is considered altogether orthodox, even though recorded anthropomorphically as the soliloquy of a bird about to start on its first migration:

"To find winter quarters I must follow such and such a star pattern, which I can look at in the chart-room of my brain, and clearly remember because I was given a whole set of charts of the celestial patterns which matter to me before I was born. I have a reliable chronometer in my light-sensitive biological clock, which was correctly set by local solar (or sidereal) time as soon as the first flash of light greeted me on hatching. So I can read every movement of the stars each hour of the night, and compensate for their movements so as to head in a straight line south. If I go south beyond the Equator I shall lose the North Star (my friend and



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guide up north), but other bright stars will come up to guide me. . . . Of course, I shall also recognize winter quarters, although I have never seen them before . . . because the position of winter quarters under certain stars and the local physical appearance of the region is also recorded in the chart-room, from the data I inherited in my genes from both parents. Finally I have this overwhelming desire to fly, also genetically determined for me, for a limited period during which I must achieve winter quarters before the impulse dies, or my (fat) reserves of energy run out."

Robert Cushman Murphy is Lamont Curator Emeritus of Birds at The American Museum of Natural History.

CONGRESS AND THE ENVIRONMENT, edited by Richard A. Cooley and Geoffrey Wandesforde-Smith. *University of Washington Press, $8.95; 277 pp.*

Recognizing that a solution is no solution without implementation, Americans concerned with protecting the environment are giving increasing attention to the workings of the federal government. The result is a new field—environmental policy—and the appearance of this fine collection of essays. *Congress and the Environment* is the product of an extended seminar at the University of Washington. At the time the volume was written, the contributors were, for the most part, untried graduate students and beginning professors. But the editors, whose guidance is evident throughout the book, are established scholars. Moreover, Grant McConnell and Lynton K. Caldwell, the leading figures in environmental policy, have contributed characteristically perceptive essays in the form of a prologue and epilogue. The quality of this book i evidence that properly directed grad uate students constitute a scholarl resource we cannot afford to ignore

Congress and the Environmen makes its point in no uncertain terms The common denominator for all th essays is the assumption that th United States government, and Cor gress in particular, have not re sponded satisfactorily to environmen tal problems. Again and again th reader is provided with examples o how the nature of the American poli ical process prevents meaningful solu tions. Specifically, the authors iden tify five liabilities: (1) the lack of national policy respecting the env ronment and the consequent tendenc toward narrow, short-term, piecemea solutions; (2) the eclipse of ethica and esthetic considerations by materia ones; (3) poor institutional arrange ments—particularly the congressiona committee system—for handling env ronmental issues; (4) a preference fo compromise rather than leadership and (5) a reluctance to challenge pr vate property and corporate interest fo societal good. Congress, the contrib utors agree, muddles and stumbles i eptly where the environment is co cerned. It is frequently paralyzed, dea negative, and irrelevant even in the fac of crisis. The tone of this book is unde standably gloomy. Only a few co gressional successes relieve the chro icle of failures.

The core of this volume is th series of case studies that put flesh c the bones of generalization. We a taken to the Indiana Dunes, tl North Cascades, and the Redwoo for analyses of federal policy. Oth essays concern particular laws su as the Land and Water Conservati Fund Act, the Highway Bea tification Act, and the Wilderne Act. Still others take up such speci problems as water quality standar solid waste disposal, and noise poll tion. Most of the contributions a legislative histories, which trace t formation and implementation of act while drawing the political s ence moral. In most cases the a counts are the best in print for the respective subjects.

While only minor caveats can made with respect to the case studi it is possible to question the maj theme of *Congress and the Enviro ment* to the extent of asking, "Is Co gress really to blame?" Granted th many improvements in congressio procedure could be made, still it a pears that the electorate must at lea share the blame for environmen deterioration. Lynton K. Caldw suggests this when he states that '

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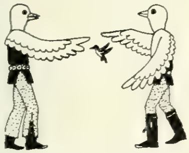

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shape the environment of a civilized society means nothing less than shaping the nature of the society." He goes on to ask, "Does the structure of American society—pluralistic, democratic, historically biased in favor of an 'everyman's laissez faire'—permit the shaping of its environment in any way other than by combat and compromise?" Few others in the book are similarly concerned about whether it is the American or his Congress that needs improvement.

Extending this idea, it can be argued that current congressional policy is really quite an accurate reflection of the environmental tastes of Americans as a whole. We must remember that the vogue of environment is not universal in our society. We are still in transition from the old pioneer, exploitative ethic to a newer one based on ecology and stewardship. Many Americans are ambivalent. They like wilderness, for instance, but they also like mines and mass. mechanized recreation. In view of this, the Wilderness Act may have been a very accurate expression of the national desire in 1964. Political scientists and conservation leaders may gnash their teeth in frustration, but Congress is adjusting about as fast as American thought in general to the new environmental imperatives. We need, it would seem, to resurrect the old Jeffersonian maxim about educating the electorate. Good government will follow.

Roderick Nash
*University of California
Santa Barbara*

Looking for Dilmun, by Geoffrey Bibby. *Alfred A. Knopf, $10.00; 383 pp., illus.*

This is a delightful and informative work that should be on the bookshelf of every archeology buff. For some fifteen campaigns, Mr. Bibby conducted excavations and surveys at various points along the eastern coast of Arabia and on islands in the Arabian Gulf. The results are striking and important, for they document hitherto largely unknown ancient cultures lying along the sea roads that link Mesopotamia and India. Bibby worked at sites on the island of Failaka near the mouth of the combined Tigris-Euphrates rivers of Iraq, and at such places as Thaj, Qatar. and Abu Dhabi on the Arabian mainland. His work on the island of Bahrain. where some of the most extensive ancient cemeteries in the world are located, is probably the best known.

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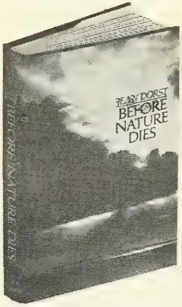

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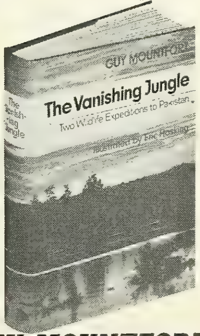
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ing east and south of their territories with whom they traded. Among these, Dilmun, Makan, and Meluhha have especially intrigued modern researchers. Bibby's work now makes clear that Dilmun, at least, was an extensive mercantile culture stretching for hundreds of miles along the Arabian coast, but centered on the island of Bahrain. The amount of material evidence he and his numerous colleagues have unearthed is monumental. Architecture, sculpture, metal work, seals, and pottery graphically depict a culture thriving on the proceeds of mercantilism from the early third millennium B.C. to as late as 600 B.C. One of the most important finds was the presence of prehistoric village sites on the mainland whose artifacts identify them as belonging to the Ubaid culture of Mesopotamia. This culture lies in the direct line of development that led to the birth of Sumerian civilization, the earliest such cultural form in the world. The presence of these early villages so far to the southeast of Sumeria suggests that between 4000–3000 B.C. there must have been strong motivations for movement in search of land and other resources in the region. Settled life is a necessary prerequisite of civilization, and in the spread of the Ubaid we witness the sowing of the seeds of early civilization.

The book teems with ideas, with descriptions of finds, with familiar tales of fund-raising, government permission-seeking, and expedition problems. It is all told with charm and fluency, supplemented by meaningful drawings, maps, and photographs. It is worth its cost twice over.

W. A. FAIRSERVIS, JR.
The American Museum

DEFOLIATION, by Thomas Whiteside. *Ballantine Books, Inc., $.95; 168 pp.*

On June 16, 1962, the *New Yorker* magazine published the first section of a three-part article by Rachel Carson. Subsequently published in book form, *Silent Spring* stirred up a storm that has still not abated. It has been said that county agricultural agents, normally nonreaders of the magazine, circulated it even in Dubuque, Iowa—where the *New Yorker* is not supposed to be found. Only this year did federal authorities move to limit the use of DDT, a pesticide that Miss Carson discussed in great detail.

Within the logical framework of a large-scale military operation in Vietnam, there were excellent reasons in 1961 to initiate a program of defoliation and herbicide spraying. Enclaves and potential ambush sites could be quickly opened up in the jungle areas of the country, and the mangrove associations lining the rivers could be eliminated to prevent sniper fire directed toward our patrol boats. By extension of the scorched-earth policy, used militarily since at least the time of Attila the Hun, crops could be destroyed to deny food to the enemy. A variety of effective compounds were available, there was a reasonable level of sophistication on the use of the materials, and cargo planes could be quickly fitted with tanks and spray nozzles. The military benefits were obvious and, with no one to say them nay, the military began what has since escalated into a massive program of defoliation and herbicidal treatments. Both civilian and military authorities have stated categorically that the program is successful within the context of military goals and that American and Allied lives have been saved.

A few voices were, of course, raised in protest. Some of the critics were so antiwar that they might be presumed to object to anything that the Pentagon suggested. A few people were concerned with questions of the morality of destroying food. A small group of plant physiologists, ecologists, conservationists, and applied plant scientists pointed out that there

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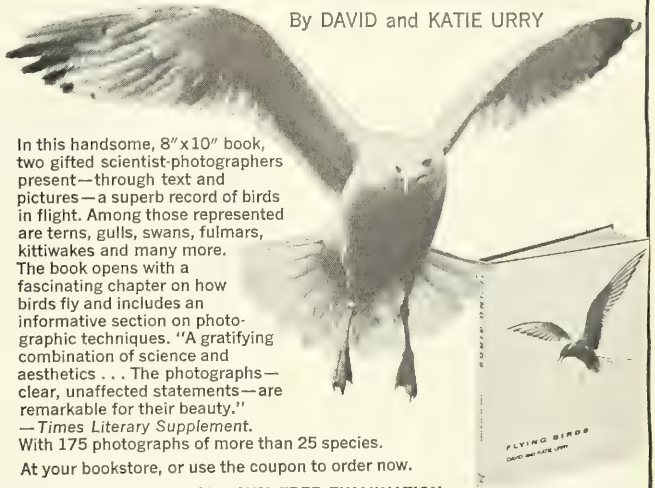
were, in addition to the military benefits, an array of actual and potential costs and dangers that had to be included in any assessment and balance sheet. But in general, our citizens were not aroused. In part, this can be attributed to a lack of personal and immediate involvement—Vietnamese forests and rice paddies are 3,000 miles away. Active or passive support for our "mission" in Southeast Asia serves to preclude dissent from any practice that is stated to advance the policies of the Pentagon and the administration. Another factor, one that this book can provide, has been a lack of information. The public has not been supplied with hard facts on the compounds used, the concentrations applied, the plant species affected, the persistence of the compounds, or their side effects. We haven't even been presented with an equivalent of a body count!

Bits and pieces of data have, of course, appeared in professional journals, but these were inadequate even for the professional biologist. I know of only two visits to Vietnam by professional scientists looking specifically at the consequences of defoliation and herbicidal action, one by a forester and the other by a team of two animal ecologists. In addition, a trickle of reports from the military, a hearing by a congressional committee, and a few other odds and ends are all we have with which to begin even a preliminary assessment of the immediate and long-term consequences of "Project Ranchhand" and other equally fancifully named spray programs. Yet, a fairly small piece of real estate about the size of Rhode Island has been subjected to the most massive exposure to phytodestructive chemicals that has ever occurred.

The *New Yorker* again performed a public service in first presenting Thomas Whiteside's essay and letter of amplification. Ballantine Books, in cooperation with Friends of the Earth, has augmented this service by putting the information into an inexpensive, paperbound volume. The *New Yorker* information has been supplemented with a preface by Prof. George Wald, by documentation of the statements, and with several form letters to be sent to congressmen and secretaries of various governmental agencies, to international administrators, and to the President. A useful and comprehensive index is included.

Defoliation probably won't stir up the controversy that *Silent Spring* did, partly because we have become inured and cynical. But it is accurate, carefully crafted, adequately docu-



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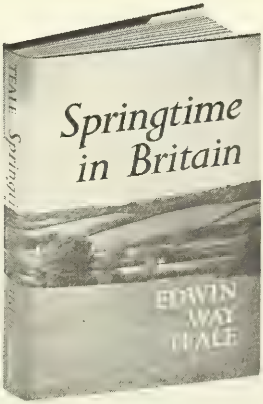

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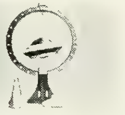

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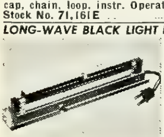

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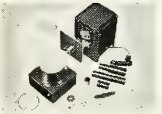

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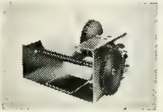

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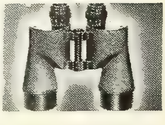

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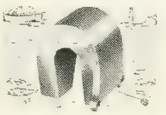

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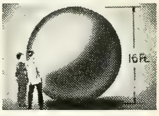

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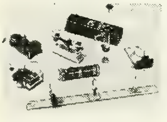

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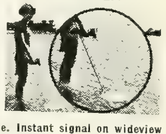

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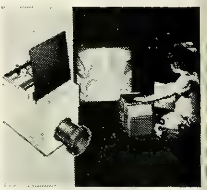

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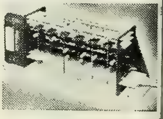

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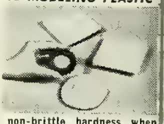

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RICHARD M. KLEIN
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The editor, C. P. Idyll, has written
excellent introduction and also,
ith Hiroshi Kasahara of the United
ations Development Program, a real-
tic appraisal of present and poten-
al food from the sea, which together
ith C. F. Hickling's account of
rming in the sea, should bring some
arry-eyed population optimists down
earth where we all belong. Other
sources of the sea are interestingly
d sensibly discussed by Robert
ietz of the Environmental Science Services Administration, while the physics and chemistry of the sea and of seawater itself, the sweep and power of currents and waves, and the great complexity of the mineral solution, which in essence we retain in our blood to this day, are well presented by James Rucker and Neil Anderson of the U.S. Naval Oceanographic Office. My only complaint with regard to the section on winds and currents, man's primary interest since accurate navigation led the way to the exploration of the ocean as a whole, is that no mention is made of William Dampier. The most romantic sailor of all time, he discovered the fundamental features of the trade winds, published a book on the winds and currents of the world, and was a member of a group of pirates who sailed with Henry Morgan.

Last but not least are the chapters on the biology of the sea, by Charles Lane; on underwater archeology, by Mendel Peterson; and particularly, the one by Robert Dietz on the underwater landscape, which emphasizes the rapid coming-into-focus now taking place with regard to both the making of oceans and the not-too-distant past fragmentation of a world continent. The book ends with an article on man beneath the sea, by Capt. Edward Beach of the Naval War College, an appropriate and perhaps slightly ominous ending that shows modern technological society about to take over the sea as it has the land, all for man's benefit. Whether man can survive on earth is in doubt; also doubtful is whether the frail and lovely ocean and the land it surrounds can survive human ingenuity.

N. J. BERRILL
Swarthmore College

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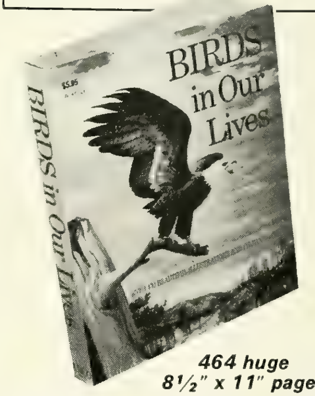

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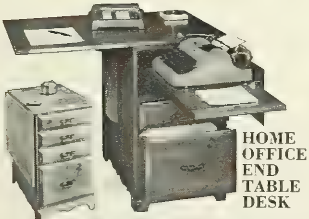

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THE MARINE MAMMALS OF THE NORTHWESTERN COAST OF NORTH AMERICA. C. M. Scammon. Dover Publications, Inc., New York, 1968.

MAKING FRIENDS WITH A KILLER WHALE. E. I. Griffin. *National Geographic*, Vol. 129, pages 418-466, 1966.

GEORGIA GRANITE

STUDIES OF THE FLORA OF THE GRANITE OUTCROPS OF GEORGIA. W. B. Baker. *Emory University Quarterly*, I, pages 162-171, 1945.

THE VEGETATION OF THE GRANITIC FLAT-ROCKS OF THE SOUTHEASTERN UNITED STATES. R. McVaugh. *Ecological Monographs*, April, 1943.

PEOPLES OF INDOCHINA

THE MAKING OF SOUTHEAST ASIA. G. Coedes. University of California Press, Berkeley, 1966.

SOUTHEAST ASIAN TRIBES, MINORITIES AND NATIONS. P. Kunstadter, ed. Princeton University Press, Princeton, 1967.

SOUTHEAST ASIA: CROSSROADS OF RELIGIONS. K. P. Landon. University of Chicago Press, Chicago, 1969.

LIFE IN THE SKY

CLOUDS, RAIN AND RAINMAKING. B. J. Mason. Cambridge University Press, New York, 1962.

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JAPANESE TOYS: PLAYING WITH HISTORY. K. Sanobe and K. Sakamoto. Translated by C. Pomeroy. Charles E. Tuttle Co., Inc., Rutland, 1965.

THE FOLK ARTS OF JAPAN. H. Munsterberg. Charles E. Tuttle Co., Inc., Rutland, 1958.

DISSECTING THE CRAB

EXPLORATION OF THE UNIVERSE. G. O. Abell. Holt, Rinehart & Winston, Inc., New York, 1969.

ASTRONOMY OF THE TWENTIETH CENTURY. O. Struve and V. Zebergs. The Macmillan Company, New York, 1962.

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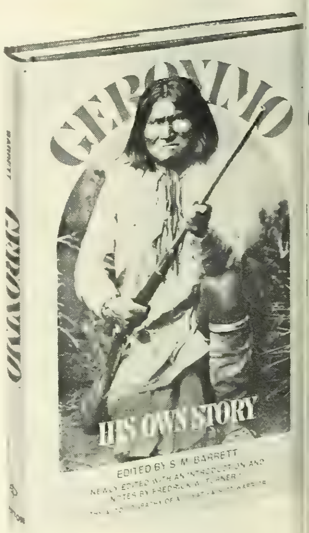

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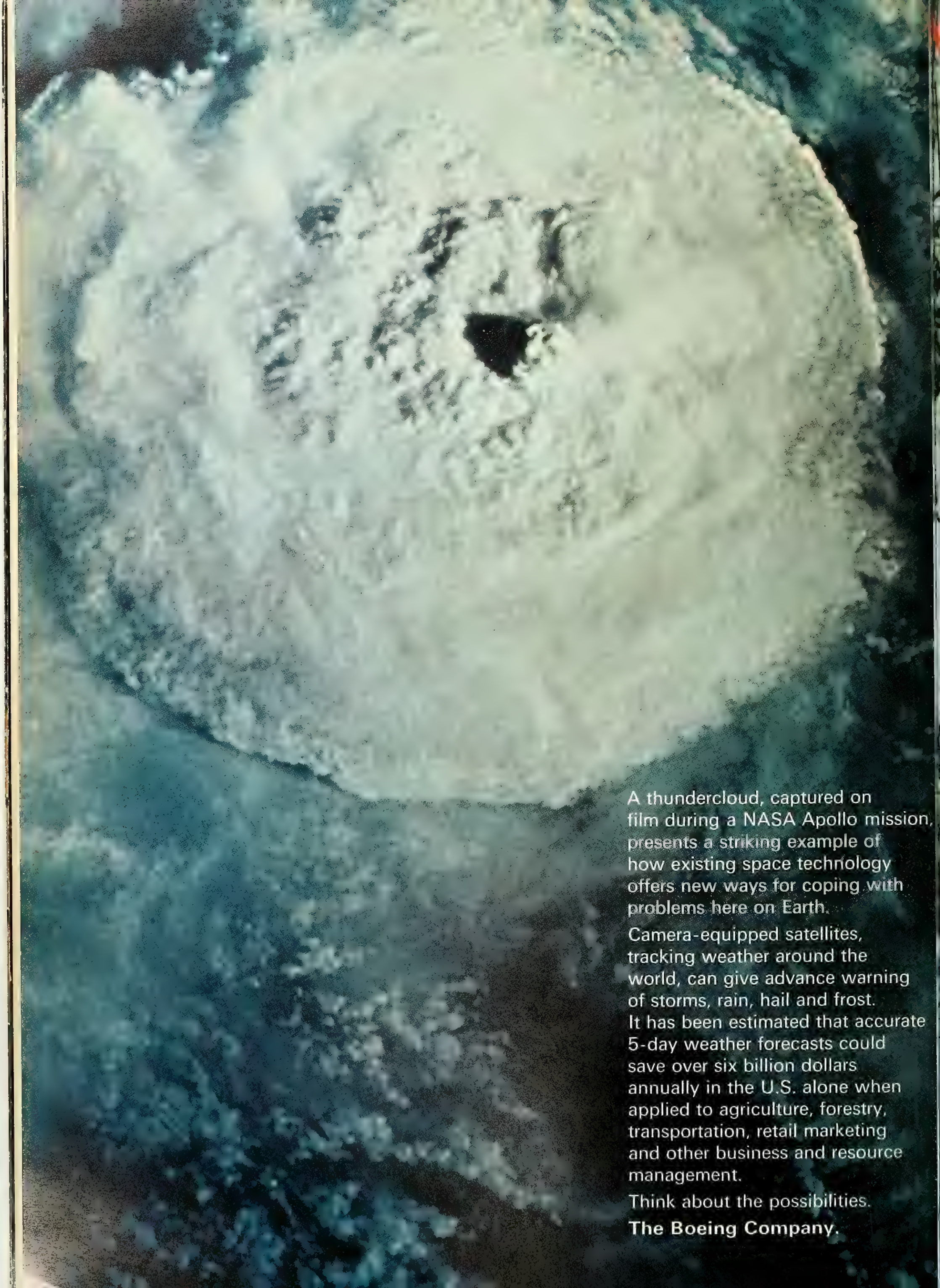

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The Journal of The American Museum of Natural History

Vol. LXXIX, No. 9 *November 1970*

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88 SUGGESTED ADDITIONAL READING

COVER: *During rough Idaho winters, the elusive mountain lion follows his prey into the valleys, where his tracks record the events of his wanderings.*

**. . . but were afraid to ask.*

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Publication Office: The American Museum of Natural History, Central Park West at 79th Street, New York, N.Y. 10024. Published monthly, October through May; bimonthly June to September. Subscription: $7.00 a year. In Canada and all other countries: $8.00 a year. Single copies $1.00. Second-class postage paid at New York, N.Y., and at additional offices. Copyright © 1970 by The American Museum of Natural History. No part of this periodical may be reproduced without the written consent of NATURAL HISTORY. *Manuscripts and illustrations submitted to the editorial office will be handled with care, but we cannot assume responsibility for their safety. Opinions expressed by authors are their own and do not necessarily reflect the policy of The American Museum.* NATURAL HISTORY *incorporating* Nature Magazine *is indexed in* Reader's Guide to Periodical Literature.

The fishing i

When fishermen first saw oilmen drilling in the Gulf of Mexico some twenty years ago, they were shocked. "The fishing will never be the same," they said. And they were right.

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Among these are the aristocratic pompan

And the big fellows seem to be mov
closer too. The annual Tarpon Rodeo at Gr
Isle, in the heart of Louisiana's offshore
fields, is now one of the largest fishing cont
in the United States.

Jersey's affiliate, Humble Oil & Refin
Company, operates many of the offshore w
Here's how they explain the fish phenomen

CRIMSON TIDE

etter than ever.

When the legs of a platform are thrust into cean floor, they attract various forms of ne life, such as plankton, algae and barna- These attract small fish. And the small fish ct big fish. And so on and so on, in the eat-fish rhythms of the sea.

For Jersey or Humble to claim credit for natural process would clearly be absurd. imply point out that it might not happen if we ran our oil platforms without caring about the waters in which they stand.

By the way, commercial fishing in the gulf is going great guns too. Trawlers are now catching over four times the weight of fish they caught in 1940.

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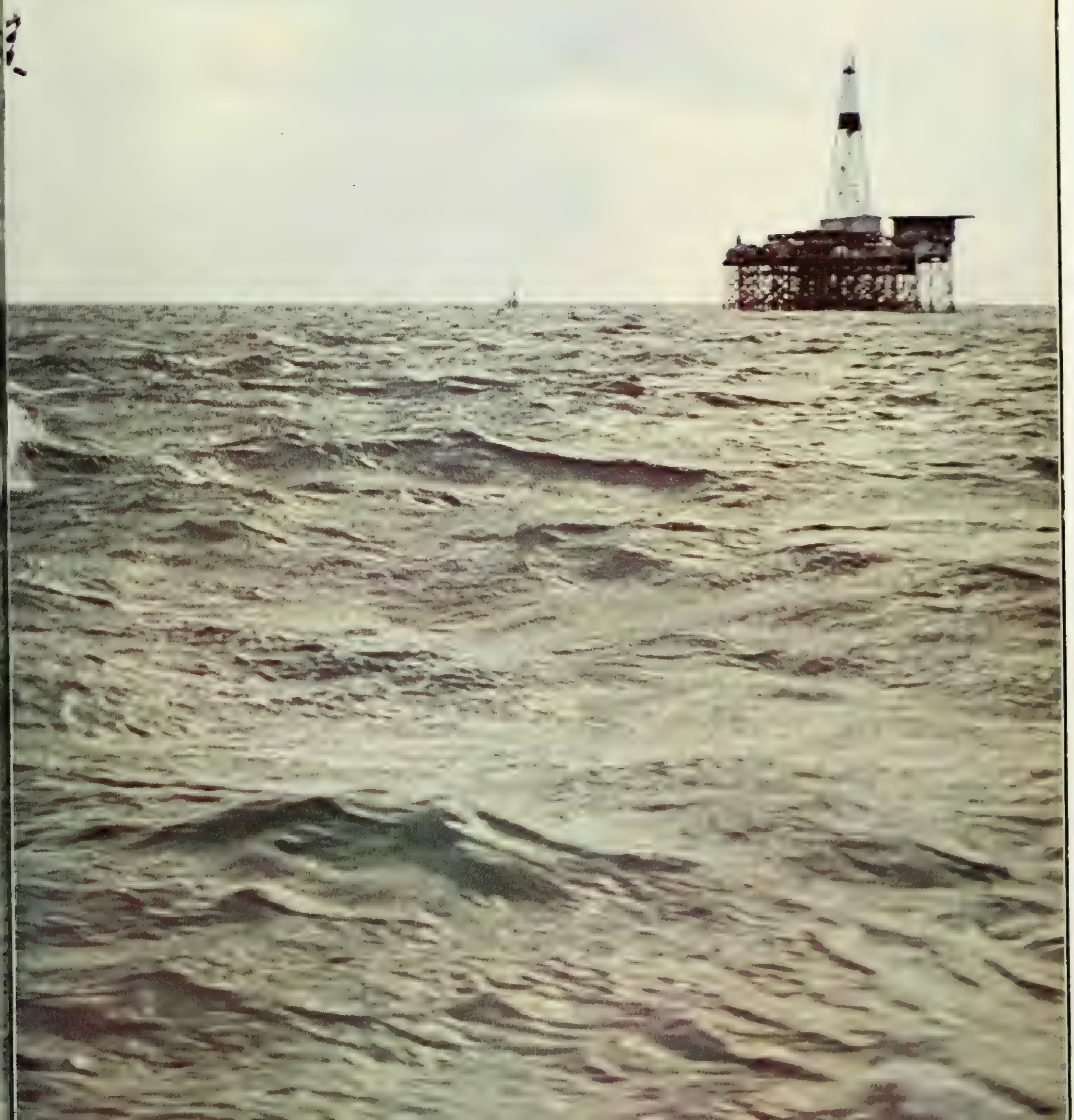

In this superb new book you'll see many tropical birds never before photographed. And many that may never be photographed again.

Portraits of Tropical Birds began as a labor of love and grew into a ork of camera art and scientific achievement. For John S. Dunning, a Field ollaborator of the Cornell Laboratory of Ornithology, the goal was to photograph s many of the neotropical birds of Central and South America as time and effort ould allow. And, to photograph them under conditions as near to their natural nvironment as humanly and technically possible.

The result is a beautiful book and eloquent testimony to Dunning's uccess. Here, the birds of Central and South America are captured on film by a asterful photographer and an ornithologist of exceptional skill and patience. unning's tireless tracking of the lowland jungles and awesome mountain anges has produced stunning portraits of birds never before hotographed. Many are virtually unknown to ornithologists, and thers, near the brink of extinction, may never be photographed again.

Hummingbirds and trogons, jacamars and motmots, puffbirds and oucans, the Andean cock-of-the-rock, are represented in all their magnificent lumage. Above all, are the tanagers, brilliant blue or iridescent green, crimson r gold, photographed in their characteristic attitudes.

These handsome portraits constitute a permanent record of each pecies. The scientific value is great. The photographs are superb. The text offers ascinating insights into how much—or more often, how little—we know f these tropical birds.

In an absorbing chapter, Dunning tells of techniques he had to evelop to photograph his fragile and elusive subjects under natural or ear-natural conditions. The equipment he used is clearly described, o encourage other nature photographers.

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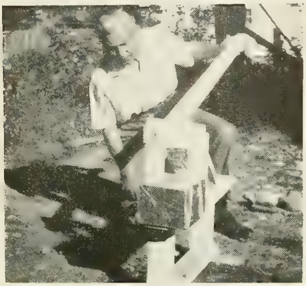
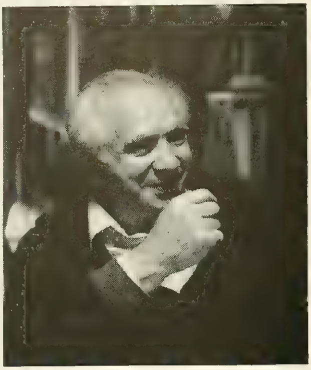
Authors

A retired design engineer, **Olaf Tellefsen** was born in Arendal, Norway, and came to the United States in 1928. Professionally trained in Norwegian schools, Tellefsen's life-long avocation has been the analysis of ancient structures from an engineering point of view. He has made many trips abroad—to Egypt, Greece, Italy, and Stonehenge—in pursuit of additional information with which to test his theories.



John Eastman, author of "Powwow," is a free-lance writer from Kalamazoo, Michigan. He received a B.S. degree in biology from Western Michigan University in 1965, and has since worked as a biological assistant for the Illinois Natural History Survey and as a manuscript editor of biological textbooks. His previous works for NATURAL HISTORY include "A Field Guide to Field Guides," November, 1969, and "Biology of the Way-Out," May, 1970.

Born in Rypin, Poland, artist **Mortimer Borne** came to the United States in 1916. After a period of experimentation, he pioneered in the technique of color drypoint using three plates. A former lecturer of art at the New School for Social Research, Borne has had one-man shows at the Corcoran Gallery of Art, the Museum of Fine Arts (Montreal), and the Smithsonian Institution. His works are in many permanent collections, including that of the Library of Congress and the Rosenwald Collection of the New York Public Library. Borne currently resides in Nyack, New York.



The destruction by deathwatch beetles of the roof of his cleric father's country church triggered **Martin Birch**'s interest in insects, an interest that eventually led to a Ph.D. in entomology from Oxford University. A native of England, Birch is currently a lecturer and research fellow at the University of California at Berkeley where he is working on bark beetle control. He is also continuing his research on pheromones in Lepidoptera, with emphasis on chemical communication in animals for possible application in pest control without harmful side effects. His work has taken him to Denmark and Crete to study ladybird beetles, Moscow and West Germany for research with moths, and Kenya where he studied army worms and termites.

Leader of the Idaho Cooperative Wildlife Research Unit at the University of Idaho, **Maurice G. Hornocker** received his B.S. and M.S. degrees from the University of Montana and his Ph.D. from the University of British Columbia. Hornocker's work on magpie–pheasant relationships, and his research on raptors, grizzly bears, and mountain lions have earned him a respected position in the field of animal behavior. His present research focuses on the ecology of predation.

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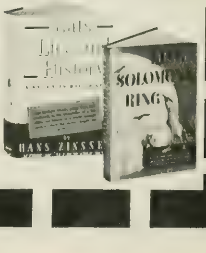

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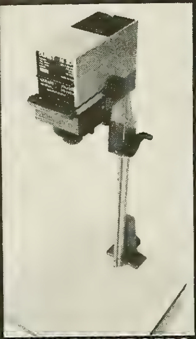

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Assistant professor of biology at Trent University in Ontario, **Michael Berrill** spent the summer of 1969 observing marine animals in Norway. His objective in exploring deepwater fauna was to find an invertebrate subject for studies of the development of behavior. Berrill, who earned his M.S. at the University of Hawaii and his Ph.D. at Princeton, both in biology, is the author, with N. J. Berrill, of *Life of Sea Islands*. His field work has taken him to the Caribbean, Japan, and Newfoundland.

David Werner, author of "Healing in the Sierra Madre," has been the director of Project Piaxtla for the Hesperian Foundation since its inception in 1965. The aim of this project has been to improve the health and living standards of the villagers in Mexico's isolated "las barrancas" region. Werner received his B.Sc. in biology from the University of New England in New South Wales, Australia, and supervised the high school student article, "Sabino Grove Ecology Study," which appeared in the May, 1965, issue of NATURAL HISTORY.

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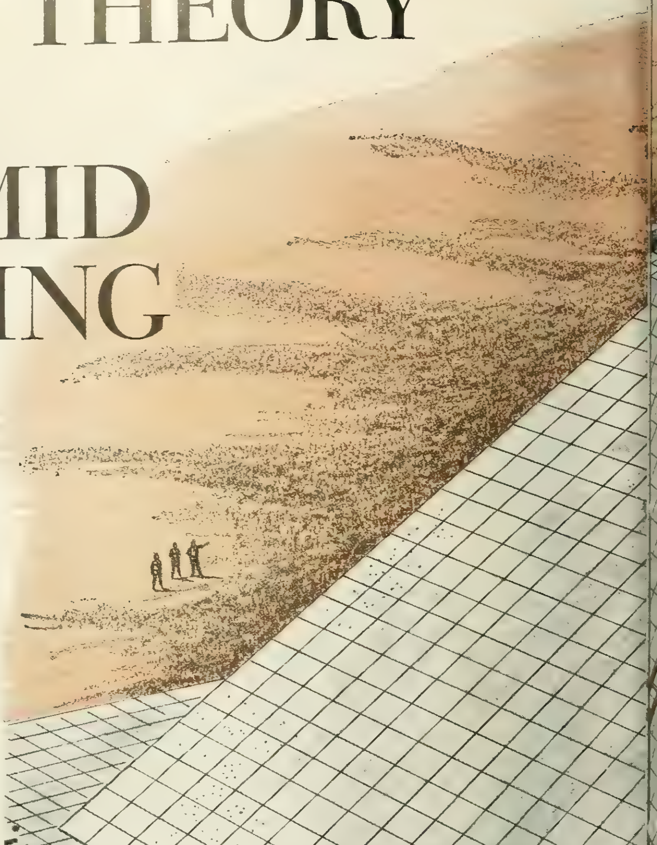
A NEW THEORY OF PYRAMID BUILDING

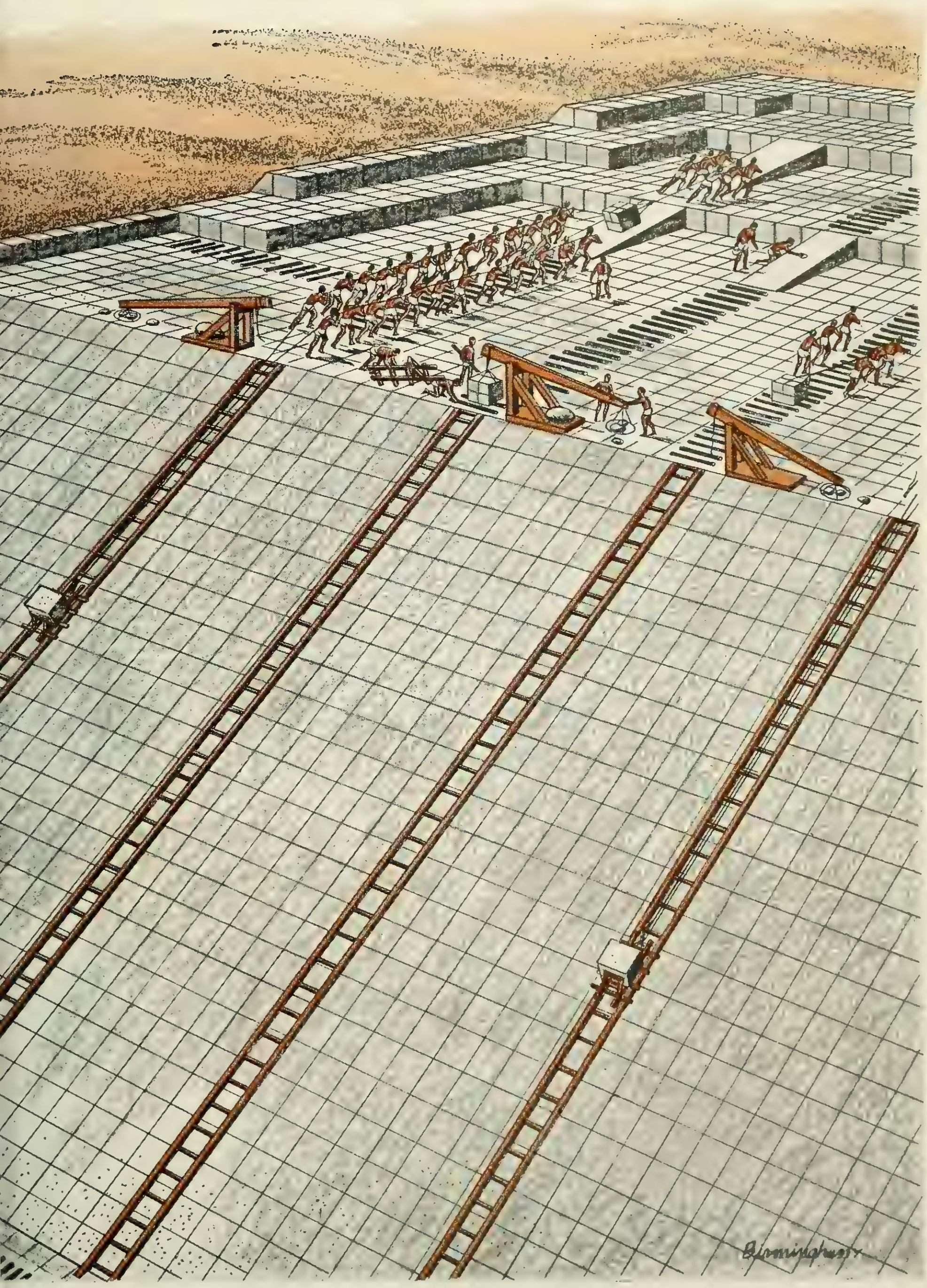
After 5,000 years of speculation, a fresh approach eliminates the need for a Cecil B. deMille set and a cast of 100,000

by Olaf Tellefsen



Egyptologists and engineers have been fighting over the great pyramids for years. The archeologists hold for a hundred thousand men hauling three-ton blocks up earthen ramps more mammoth than the pyramids themselves. The engineers produce pages of calculations to show there wasn't enough manpower in all Egypt to build such ramps, and further, that the Egyptians couldn't have gotten enough men on top of a pyramid, even with scaffolding, to heave the huge top piece into place.

The engineers have not come up with anything to replace the ramp theory, however. The problem is simply stated: Devise a means of building a 480-foot-high monument out of more than two million 3-foot-square blocks of stone, without using any power other than human or animal strength. Based upon an accidental observation in present-day Egypt, I have an answer that in-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volves the use of one simple tool easily accessible to the ancients and that does away with the need for a ramp and all but a few thousand of the postulated hordes of workers.

On a trip up the Nile some years ago, I saw three men moving large stones to the water's edge from a pile that could well have been the remains of some ancient structure. When I saw the size of the stones my engineering sense told me that I had run across a technological curiosity of note. The primitive piece of equipment the men were using was a triumph of elementary physics—a large weight arm, consisting of a heavy timber that pivoted on a sturdy, 6-foot-high fulcrum. The short arm was less than 3 feet long; the long arm 15 to 16 feet. A pallet was attached to the long arm, upon which rocks could be piled for counterweight. While the unit was roughly built, apparently with no tool other than an ax, it served its purpose admirably.

As I watched, the men slid a sling under one of the stones, looping the bight over the short end of the weight arm where one man held it in place while the other two piled rocks on the pallet. They piled on rocks until it almost balanced, then brought the beam down by adding their combined weight. That lifted the big stone about a foot, enough for the third man to place planks, rollers, and a pair of runners under it. With that done, the men at the pallet eased the stone down on the rollers and proceeded to dump the counterweight. The sling was removed, and the load was now ready for moving. Two men pushed with wooden levers while the third man shifted the rollers and leapfrogged the planks.

The block of stone must have weighed more than two tons, but the placing of it on the rollers had taken little more than ten minutes.

I felt sure the apparatus I had seen must have been based on an

In conventional explanations, the pyramid builders used giant ramps to raise the stone blocks up to the working area. The ramps either corkscrewed up the sides, as in this representation, or were built straight up to one face. Remains of ramps have been found at some pyramids, but many experts doubt that ramps were used all the way up to the 480-foot level.

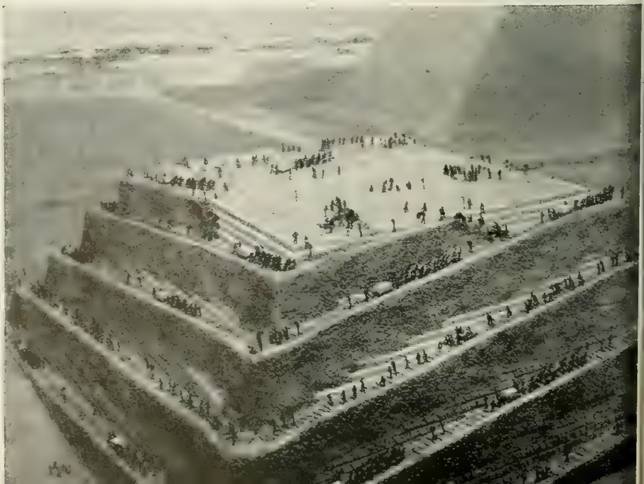

Photo-surrealism

Raindrops on a window, inches from the camera. A girl on a beach, a hundred feet away. Both exquisitely sharp, which gives the picture its special quality. But, how to do it without special equipment?

In theory, you'd first shoot the beach scene, focusing on the girl. Moments later, after rewinding the film one frame, you'd focus on the rain spattered window and make a second exposure. Quite simple, really. Except that it's impossible with most cameras because their lenses can't provide the tremendous focusing range required.

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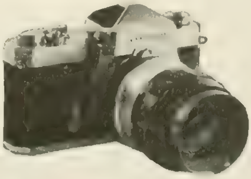

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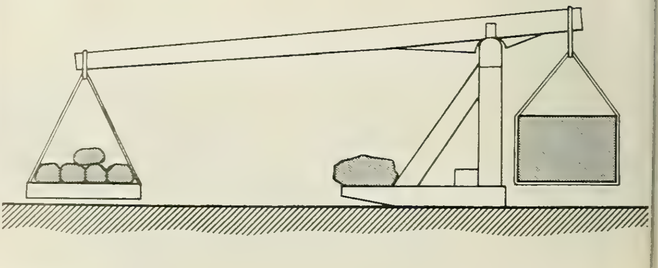
idea inherited from the past, where it had played a key role in the raising of the huge stone structures of the past, including the Great Pyramid. I could visualize a hundred weight arms being used on that great project, each serving several gangs of five or six men who, together, could easily place up to 600 of the regular building stones per day. This simple machine would reduce the manpower requirement from the assumed 100,000 to a few thousand men.

To substantiate what I intuitively felt to be true, I decided to eliminate what we positively know was nonexistent at the time, then determine what was left. The ancient master builders did not have power equipment, block and tackles, or hand winches, but they had everything else, including a firm grip of elementary physics.

The Egyptologists have concluded that, in the absence of aids more advanced than ropes, levers, and wooden rollers, the inclined plane in the form of a ramp was used "up which the blocks of stone were dragged by vast gangs of men to their position on the pile." In contrast, engineers have shown by cool figures that there was not manpower enough in the entire country to build such a ramp beyond the halfway mark. To double the height of a ramp, you must use eight times the amount of fill material and ten times the number of man days. Fifty feet or so is the practical limit. In addition, engineers have shown that the top piece could not have been elevated to the 480-foot level by manpower alone. There wouldn't be room for that many men on any scaffolding that could be erected. It seemed obvious to engineers that the builders must have used some mechanical aid, but they were unable to agree on what it might have been. The Egyptologists clung to the ramp explanation, feeling they had no clear alternative.

Built with nothing more than an ax, a weight arm enables two men to lift several tons. Counterweights are piled on a pallet hung from the long end; then the men simply pull down on that end, lifting the load with the short end.



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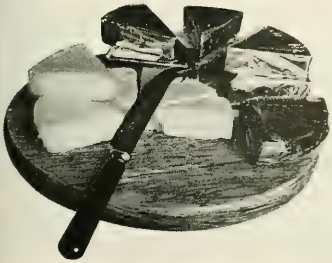

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And from them it found its way into our school textbooks.

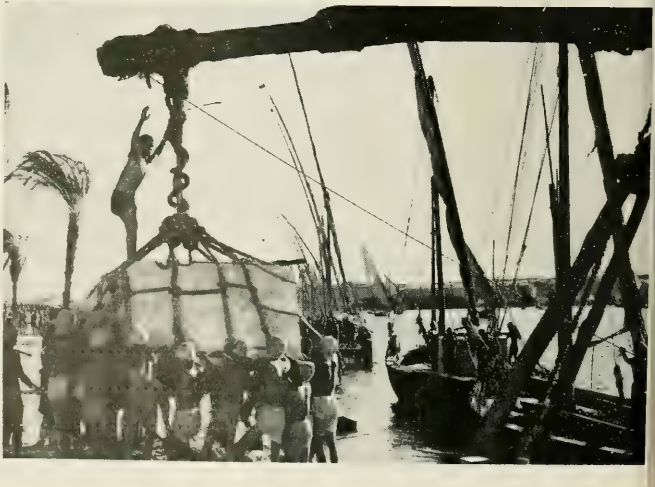
Although the situation looked discouraging, I remained confident because I had the winning ace in the hole—the missing apparatus.

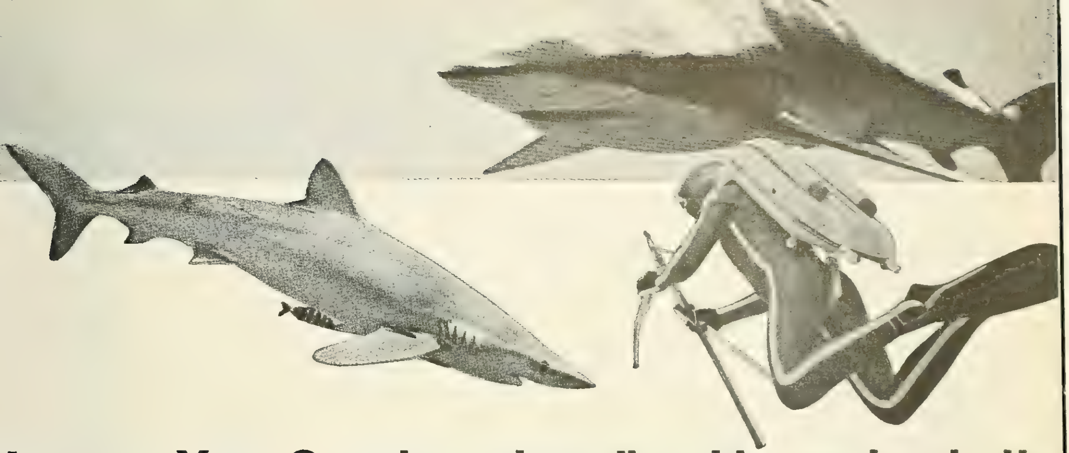
Although it has been the workhorse of peoples ever since man learned to build with heavy stones, the weight arm is so completely out of use in our power-conscious age that it has virtually been forgotten. It isn't even mentioned in our college dictionaries. The more general term lever is defined and usually illustrated, but there are many forms of the lever. Each should be defined in accordance with its special characteristics. For example, the function of a pinch bar is pushing, while that of a weight arm is pulling. A pinch bar, or pry, can only push or tilt an object, while the weight arm can pull or lift it in a sling. And theoretically there is no limit to the capacity of a weight arm.

To push a heavy stone block onto rollers with pinch bars is a slow and awkward process, and to push it onto loose skids is nearly impossible. The block must be lifted so that skidway and skids can be positioned under it, exactly as I saw it done. The Egyptologists did not consider greased skids because they knew of no way such lifting could have been accomplished. But with the weight arm greased skids suggest themselves. They are particularly practical for moving heavy loads up a steep incline, while rollers are preferable on the level. Thus, skidways of heavy planks, laid flat against the face of the pyramid from ground to working level, would be the ideal means for elevating the stone blocks. Several gangs of 25 to 30 men each would do the pulling, using a two-part tackle. Although they did not have pulleys as we know them, a rounded piece of hardwood, well greased and covered with a loose leather sleeve, would serve equally well.

For the lower half of the pyramid as many as 30 skidways would be necessary, each with a weight

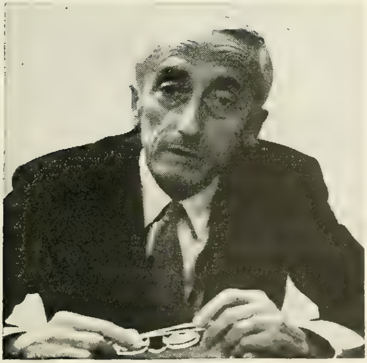
An approximation of a weight arm turned up in pyramid-building scenes in a 1955 film, *Land of the Pharaohs*. The load-bearing end appears to be far too long to be practical, however.





Jacques-Yves Cousteau describes his new book, the first to come directly out of the greatest undersea adventure in history

The Shark



Alex Gotfryd

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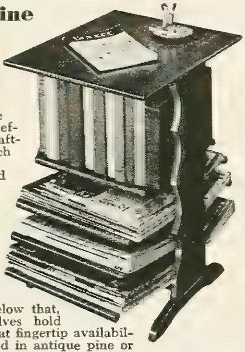

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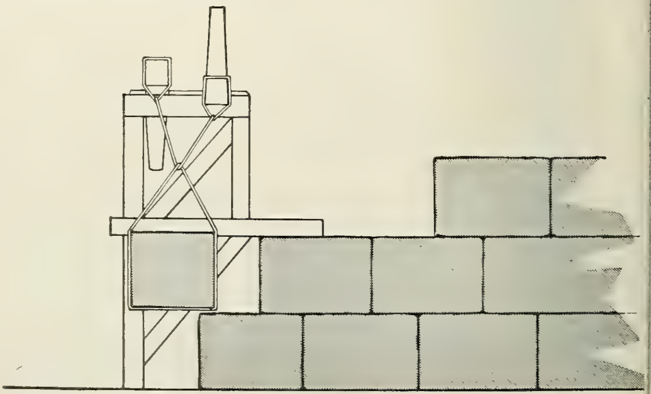
arm at top and bottom for transfer of the stones. Ten pulling gangs would be needed, each serving three skidways. At the halfway level, for example, each gang could pull three stones per hour or a total of 300 per day for all ten gangs. This quantity could easily be placed by 100 placing gangs of five or six men each. Then, assuming there were 100 delivery gangs, also of five or six men each, for pushing the blocks on rollers from the staging area to the skidways, and 200 masons with as many helpers for the passages and chambers, it would appear that 3,000 men could have raised the pyramid. In that figure are included masonry dressers, repairmen, and riggers.

The huge stones and slabs for the passages and chambers would be moved on timber skidways by banks of weight arms, rigged for lateral pull. The top piece would be hauled to its position by two banks of weight arms, which could move it about a foot with each bite. A scaffold on three sides of the pyramid top would accommodate the weight arms and their operators.

As to the regular masonry, it is most probable that three courses would be completed before each extension of the skidways. The blocks would be elevated to each second and third course by means of portable wooden ramps of easy incline, and placing gangs would double up for the short push uphill. The exception would be in the pull-up area itself where there would be no room for such ramps. There, the blocks would be lifted with dual weight arms—one to lift and one to pull sideways. Incidentally, Herodotus mentioned some such rig, calling it "a machine made of short planks." The full passage, in Rawlinson's translation, reads: "The Pyramid was built in tiers, battlementwise, as it is called, or, according to others, stepwise. When the Pyramid was completed in this form, they

A double weight arm can work in tight places. The left arm raises a block in the normal way. Then the right arm is lowered and the sling attached. When it is raised, the block will move to the right as well as up.



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Willie Sam Roberts is one of the luckier children in his Southern Tennessee town. He's just passed his fourth birthday. Hardly remarkable. Unless, like Willie Sam, you live in a place where one of every four children never lives to his fourth birthday. But Willie Sam has another reason to consider himself lucky. He has a future. A future that has suddenly turned bright.

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The $15 a month contributed makes a remarkable difference to the Roberts. The father has been able to realize a dream of starting a business. With an interest-free loan advanced by Save The Children he opened a dry-cleaning shop which seems to be succeeding. And which for the first time has given the family hope of a productive, self-sufficient future. That, of course, is what Save The Children is all about. Although contributions are deductible as a charity, the aim is not merely to buy one child a few hot meals or a warm coat. Instead your contribution is used to give people a little boost to start helping themselves.

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raised the remaining stones to their places by means of machines formed of short beams of wood. The first machine raised them from the ground to the top of the first step. On this there was another machine, which received the stone upon its arrival, and conveyed it to the second step, whence a third machine advanced it still higher. Either they had as many machines as there were steps in the Pyramid, or possibly they had but a single machine, which, being easily moved, was transferred from tier to tier as the stone rose—both accounts are given and therefore I mention both. The upper portion of the Pyramid was finished first, then the middle, and finally the part which was lowest and nearest the ground."

Herodotus is apparently referring here to the final dressing of the exterior of the pyramid. This is the only known reference to how the blocks were raised, and it points directly to the weight arm.

No matter what aids were used, the pyramids were still basically built with brute for

I have shown how the Great Pyramid could have been erected with only a few thousand men and without the use of a monstrous ramp. The capital question is, therefore, whether or not the engineers of the Fourth Dynasty could have succeeded without the devices I have mentioned.

Because there are no known records of on-the-spot observations or builders' perspectives, it is the popular verdict that we shall never know for sure. But we should be able to establish which is the most reasonable explanation.

Egyptologists have recently concluded, on the basis of new and more reliable evidence, that the manpower supply during the Fourth Dynasty was not as ample as previously believed. There were actually few slaves because foreign conquests were at a minimum. Instead, seasonal farm workers, who otherwise would be idle during the growing season and during high

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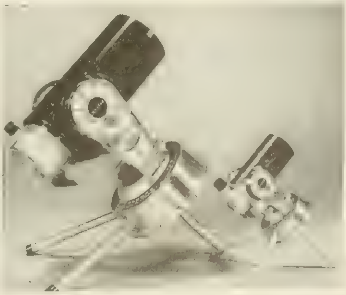

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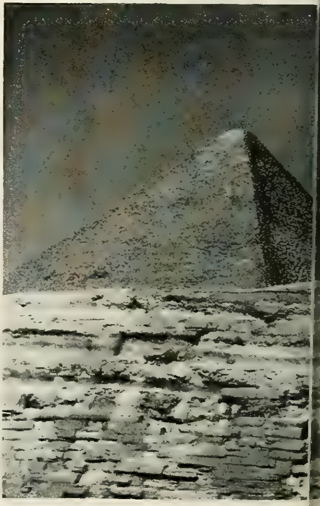
Nile, provided the bulk of the work force on the pyramid. This arrangement resulted from the Nile-oriented economy, which necessitated the maintenance of a sizable manpower pool for the short rush periods of planting and harvesting. To be available from year to year, those men had to have off-season work of a nature that would permit absences. It had become the custom of the Pharaoh to provide such work—the building of irrigation canals, temples, and tombs. Over the centuries, this continuous building activity had fostered a realm of craftsmen and engineers of a skill and creativity that has seldom been equalled, and in some respects, never surpassed. It also indicates the attainment of an extremely well-ordered society in which the Pharaoh could do his building without straining the regular industry and economy. And we must assume that his brilliant engineers planned on that basis, utilizing their technological knowhow to the utmost.



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At this point I must return the case to the Egyptologists. I hope I have convinced them that a drastic reconsideration of the entire pyramid question is in order.

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Powwow

Caught in their own stereotype and wrapped up in show biz, the Indians still evoke powerful images of America's past

by John Eastman

"Indians are definitely in the vicinity today. Many of them have come from far distances to be here. If you see one, observe carefully. Look at his face, his ornaments, his feet. You may even wish to go so far as to say 'how' to him, or talk with him. Indians are here today, ladies and gentlemen. Look around, you might see one."

The deep voice of John Bosin, Kiowa Indian, spoke over the public address system while we drank orange pop from paper cups. And see Indians we did. It was the first annual All-Indian Powwow, sponsored by the Potawatomi Indians of Michigan and Indiana, Inc. The fierce July sun beat down on the gathering at the spacious Berrien County Youth Fairgrounds, near Berrien Springs, Michigan.

Voices over the loudspeaker urged the dancers to "check sundials" and change into their costumes for the two o'clock performance, sang Indian lullabyes, or pitched for souvenir sales, causing my companion to remark, "They are very American, aren't they?"

At 2:00 P.M. the dancers—men, women, and tots barely able to walk—emerged from the rear of the grandstand, blazing like exotic birds in crafted, intricate colors. Bells and bangles jangled as they moved. Their first go-round on the concourse green was a flag ceremony, not without irony as the American flag led the proceedings. While the audience stood and the Indians paraded like Shriners, the ubiquitous drums in the middle of the field rolled out a rousing patriotic opener.

Potawatomi tribal chieftain John R. Winchester, an articulate man in a red shirt and a cowboy hat, acted as master of ceremonies. And while the show was ostensibly ceremonial, the mood was highly informal; the audience, predominantly white. However, the war dance and round dance performances indicated that for most participants the powwow was not merely a perfunctory gambol for the palefaces. The movement of Indian feet to Indian drums was practiced and well established; several young men responded with grace and restraint in a dance medium that often seems jumbled and hysterical to outside observers.

John Bosin, accomplished lead drummer and singer, introduced several respected tribal officials to the audience. While Winchester translated from the Potawatomi, Paul Hamilton of Niles, Michigan, blessed the grounds in a short, simple prayer. John Shano, an "ordained" Chippewa medicine man, cast out all resident evil spirits with a series of convincing leaps and gesticulations. And between the dances, prayers, and songs, John Winchester spoke about Indians.

He strongly protested stereotyped concepts of Indians and stressed that Indians today act and dress, try to live, find jobs, and raise children just as the rest of us do. It is astonishing that in 1970 such facts must still be announced and, further, that they come as a revelation to many. Yet despite his protest, one is forced to acknowledge that to a large degree the stereotype has been accepted and absorbed by many Indians. Some costumes, some dances, and, especially, some songs were undoubtedly authentic. But so corrupting is the Hollywood myth, so pervasive our conditioning to think of American Indians as circus performers—creatures of powwows—that one wonders who is the more deceived by a "typical" tribal dance—the performers or the audience.

In this group we saw Winnebagos, Chippewas, Cherokees, Miamis, Ottawas, Sioux, and Potawatomis—peoples once as diverse and discrete as nations—all being traditional together. But there were disturbing hints of self-mockery: Bosin's veiled sarcasms over the loudspeaker; the "shave and a haircut" theme on the drums, which invariably climaxed the dance numbers. One wonders: is this really all there is left? Do such performances signify a gigantic loss, a hole in both white and Indian cultures? Do Indians perform this way in their own, nongrandstand gatherings? One cannot avoid the impression of almost desperate self-parody beneath the surface color and ceremony. It is as if no one could be more aware of the display's circus-like irrelevance than these original Americans, force-feeding themselves on their own stereotypes. One cannot escape the sadness—for them, but also for us—of a people's faded richness.

John Winchester was aware of

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the conflicts, the ironies. "Some accuse Indians of being lazy or shiftless," he said. "But it takes tremendous energy to make one's way in two cultures, as we do. We can't make it without hard work. Being an Indian today in America is hard work. Some of us fall by the way—just as many of us have fallen in the past—but then, of course, Custer died for *your* sins." He lashed his microphone cord like a whip toward the stands.

As Bosin's drummers pounded a fast beat that rose to a frenzy (one of the drummers was named Joe Thunder), spectators armed with fast-action cameras surged from the benches to the railing, and beyond. Circus time again. Cotton candy fluffed and popcorn crunched. A child vomited down in front. A pregnant woman sitting ahead of me moaned while her husband wound film. Although a sprinkling of Indians, white-shirted and shawled, sat in the stands, none of them was taking pictures. On the grounds outside the stands, the only Indian concessionaire I saw was a silent, sad-looking woman who dipped dough into boiling oil and charged $.25 for a piece of freshly fried bread.

In the exhibition building, family craftsmen and professional traders occupied half the tables; the rest were empty. On one trader's table, stacks of "Red Power" bumper stickers lay next to "America—Love It or Leave It" decals. Beads, jewelry, miniature birchbark canoes, coonskins, and ornamental cloth of varying size and utility covered the Indian family tables. One tiny, ancient woman dressed in blue gingham dozed behind her table while dozens of white souvenir sharks fingered her display of beadwork and bookmarks.

Museum cases at the end of the row of tables displayed some old treaty maps; one faded daguerreotype showed Simon Pokagon—Potawatomi statesman, lawyer, and novelist—with his briefcase. One day, historians will rediscover Pokagon; he ranks with the wisest and ablest minds of frontier America.

Behind the museum cases, dozens of Indian family photos lined the walls. Most were simple snapshots, each with a carefully typed label identifying the persons pictured. One quickly grew accustomed to Potawatomi names: Winchester, Topash, Mackety, and Shagonaby looked like tribes in themselves. These were obviously the dominant families of the area, and we observed that, as photographs proceeded from tintype to box camera to Instamatic generations, the faces looked less and less Indian. To qualify on tribal rolls as a Potawatomi (or Chippewa) Indian today, one requires "quarter-blood minimum"—that is, one Indian grandparent.

Speaking of history, white men like their Indians hurting but proud. Yet, despite this comfortable racism and much genetic dilution, there is no ruin like that of an old Indian visage, whatever the color of the beads he sells. Nothing is so essentially American as this sight, more inspiring than any flag or anthem. Among these Indians, whose ancestors evolved with this land, we beheld faces that were true expressions—the truest perhaps—of America as it once was. They were America's product and metaphor, transcending politics, as each native organism is a metaphor of its own earthly ground, air, water, and neighbors. The most striking metaphor of all is a human face, and what we saw in many of these copper faces were place-experiences, lapsed ecologies of the continent. In some awe-inspiring, time-numbing sense, it was confrontation with truth and symbol of a depth rarely experienced in 1970, the kernel truth and symbol of our own homeland.

It is notable that the majority of Potawatomi faces at the Berrien Springs assembly were descended from outlaws and renegades. "The two Algonquin tribes (Chippewa and Potawatomi) did not at first understand the attitudes of the settlers toward land ownership," said John Winchester, "and they did not realize the full meaning of the treaties by which they ceded their acreage for small financial compensation."

Thus, in 1840, Potawatomis and Ottawas were force-marched from the Great Lakes region to reservations in Oklahoma and Kansas. This Trail of Tears migration turned into a death march as murderous and inhuman as any war atrocity. In my hometown of Kalamazoo, where many were brought in chains to await shipment, the record states that their laments could be heard for miles. "Tears formed in the eyes of many Kalamazooans as they watched the mournful procession," reads a contemporary account. But genocide with little pretense was official policy. "Groups of Potawatomis escaped from the column," said Winchester, "and returned to the lake area woodlands of Wisconsin, upper northern Michigan, and Walpole Island, Ontario, Canada."

"Most of our local Potawatomi are descendants of those who remained in the region," explains Pauline Topash Synold, an unofficial tribal historian.

One of the Potawatomis' dominant concerns now is raising money to put their youngsters through high school. The proceeds of the Berrien powwow were to be used for this purpose; Winchester made an eloquent plea on this behalf.

Just as eloquent, perhaps, is a modern story that Mrs. Synold tells about two small Potawatomi girls walking to mass one Sunday morning. Suddenly a deer came running down the street, a not uncommon occurrence in some Michigan towns. But the children were frightened because they thought a kangaroo was coming toward them. On the same day, a deer (probably the same one) tried to break into the local high school through a window. "Potawatomi Indians," says Mrs. Synold, "are becoming so assimilated into the general population and life as it is now, that our people are losing contact with nature and wildlife." An Indianlike thought occurs: perhaps the deer was trying to assert an ancient ecological connection, was trying to be an object of instruction again.

From the grandstand I could see the cloudless blue sky and heat-shimmered countryside beyond the Berrien fairgrounds. The crowd-pleasing tot in feathers and bangles drew applause again, and the "ladies and gentlemen," show biz syndrome thrived in the sweat-damp afternoon. But as Bosin and his drummers chanted a wild sound, I wondered if this land, which once included its deep Indian roots, was reawakening to an old tune. ■

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The Chromatic Wood Sculpture of Mortimer Borne

NH: How did you get started in wood sculpting?

MB: Oh, well, let's see now. I started in with traditional carving. [To Mrs. B.] And that would have been how long ago?

Mrs. B: Well, 1929, anyway.

MB: You see the chestnut figures there? About 1929 or 1928, something like that, I started to carve them. Occasionally, I would carve a piece of wood. A piece of chestnut or a piece of apple wood. Then I—oh, how *did* this come about?

Mrs. B: You became interested in color.

MB: Oh, yes. Everything I was doing . . . oh, yes, this I've got to tell you. I started to do etchings and I became fairly successful at it—won several prizes with them. You see, we had the Brooklyn Society of Etchers, later the Society of American Etchers; I won a prize—two prizes—and Mr. Armes, John Taylor Armes, was the godfather of all the American etchers, himself an etcher. I told Mr. Armes that I'm doing experiments trying to make color drypoint. He thought that was a very bad idea. In fact, he sent me a letter which I cherish. It's a long letter, four or five pages, and he's worried that America is going to lose a great talent because he himself had attempted to do color prints in etching twenty years before me and had to give it up because it just didn't work.

Mrs. B: Are you gossiping?

MB: I'm gossiping, yes. However, I continued on with the experiments. I figured that it could be done in drypoint. It had been done in etching, just a bit in etching, or in aquatint, mezzotint, tone media; but it was never done as line, color line, and after a few years—at first, I got nothing but mud, but after a while, I began to get results. Since then, I think a great number of museums have my work in the color drypoint. Where was I? Oh yes, this business here of adding color to the drypoint, making drypoints in color, made me think about the woods. Why should I depend on the texture and color of one piece of wood? At that time I was remodeling this house.

Mrs. B: Oh no, that came long before.

MB: I was remodeling this house. I learned quite a bit about woodworking tools and woods. Then came this great discovery. I bought many varieties of hardwood and that really bowled me over! There are over 50,000 varieties of hardwood, each one somewhat different in texture and color.

NH: How did this discovery hit you? How did it start?

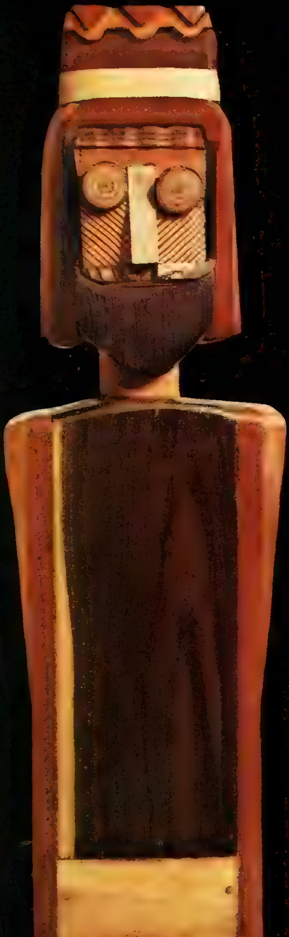
MB: [To Mrs. B.] Wasn't it the books, the Department of Agriculture?

Mrs. B: Oh yes, I started to write for information about wood, generally, because we didn't know much about different kinds of woods, and I got a government publication. When he heard 50,000, he said, "Well, if I can get 100. . . ."

MB: Yes. Then I started to do the large pieces. Large pieces. . . .

NH: Because you were remodeling the house, you got interested in. . . .

Mrs. B: I don't like to contradict him because he's forgotten. He just did that on a limited scale. He got the idea on the color drypoint to do that, and so he did a limited number of woods, you know . . . small . . . and he liked the technique. Then he got involved with other things, his painting and such. Then we moved from Brooklyn Heights to Nyack, and then he began to work more and more with tools. In other words, he did this a long time ago but not on a large scale, not huge pieces; but

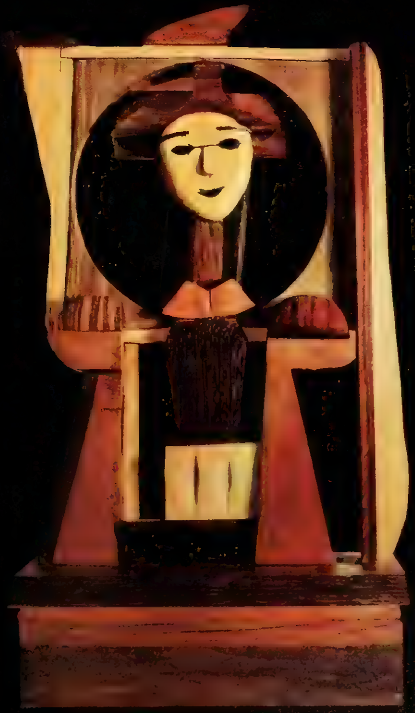


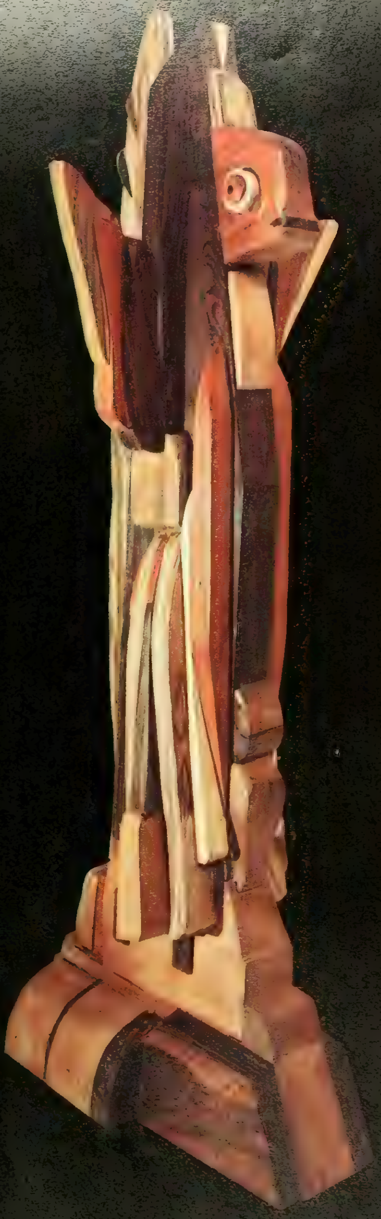
The Prophet

33 inches high

Keyhole

23 inches high



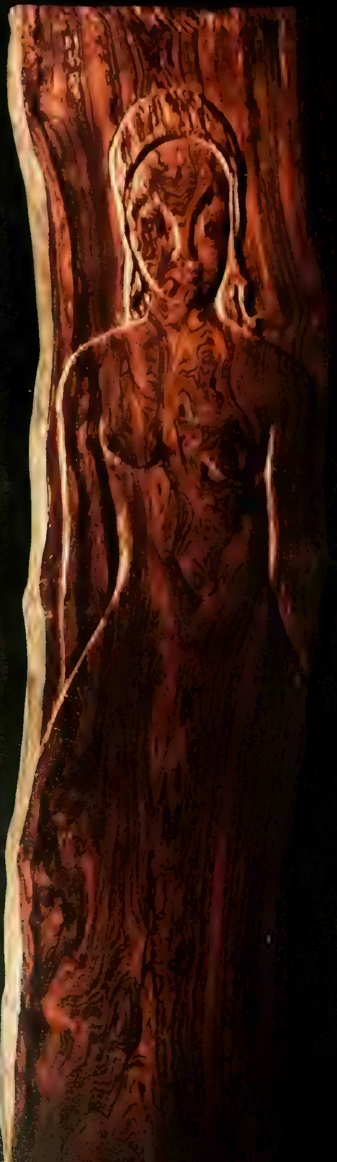


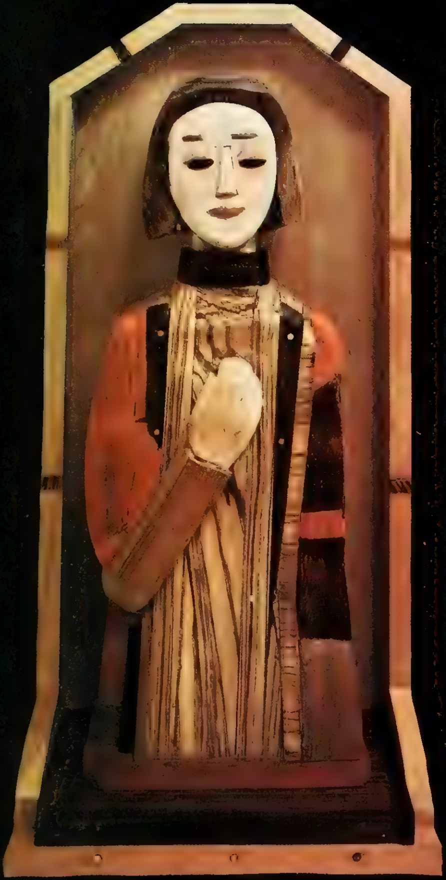
The Cherub

42 inches high

Rosewood Figure

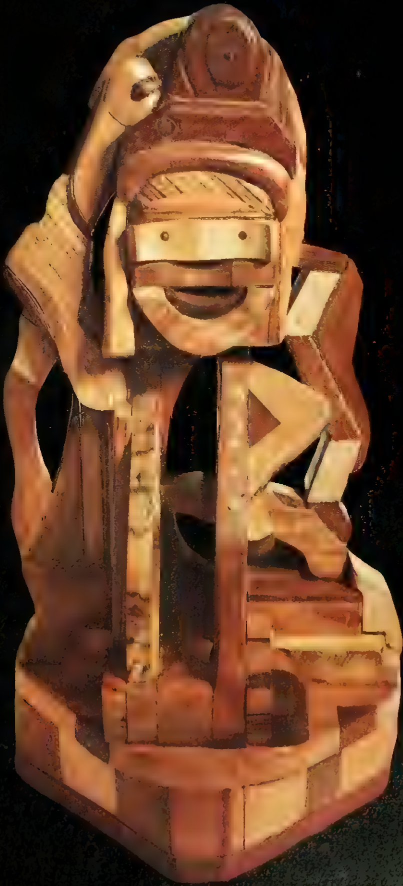
63 inches high



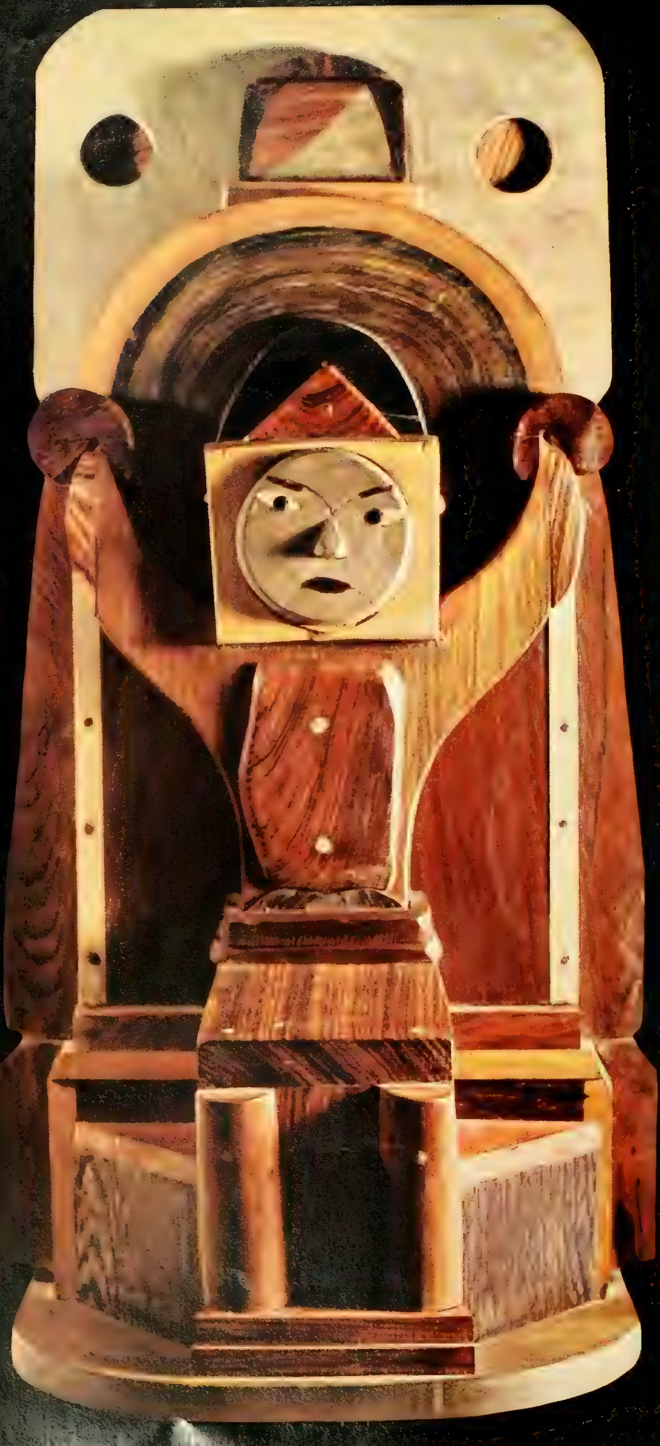


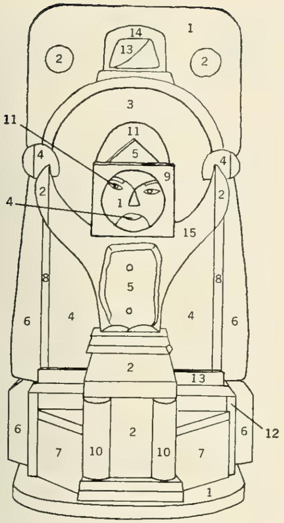
Serenity
27 inches high

Double Hinge
21½ inches high



The Moon





1. English Harewood *(Acer pseudoplatanus)*
2. Zebrawood *(Goncalo alves)*
3. Lignum vitae *(Guaiacum officinale)*
4. Purpleheart *(Peltogyne densiflora)*
5. African Rosewood *(Guibourtia tessmannii)*
6. Brazilian Rosewood *(Dalbergia nigra)*
7. Australian Blackwood *(Acacia melanoxylon)*
8. American Holly *(Ilex opaca)*
9. Korina *(Terminalia superba)*
10. Birch *(Betula alba)*
11. Black Ebony *(Diospyros ebenum)*
12. West Indian Boxwood *(Aspidosperma vargasii)*
13. Honduras Mahogany *(Swietenia mahogoni)*
14. Bulletwood *(Manikara bidentata)*
15. East Indian Rosewood *(Dalbergia latifolia)*

in the back of his mind it was like maybe he'll develop it someday. This is what happened. He came here and he remodeled this porch. Getting into wood that way. And then we began a real search into how many woods are available, where can we get them. Then we went to the forestry school at Yale just to look. They had 42,000 samples of wood.

NH: These were microscopic cross sections?

Mrs. B: That's right. They had little pieces, you see, with identification, so we read all about the different ones with the little circles. They use them to study cellular structure. They have little pieces, you know, and so we spent a whole day there. The interest grew and grew when we saw the tremendous potentiality.

MB: Then I discovered who imports woods.

NH: Who does?

MB: Well, there are several importers in New York, some in Philadelphia, one in Chicago. Here in New York you have Marshall, and also Monteath. Each one carries maybe fifty or sixty varieties of wood. All kinds. For example, they supply the people who make musical instruments, furniture, all sorts of things. And each thing is designed for a certain kind of—for example, there is a certain kind of boxwood that is used for bows of violins.

NH: How do you go about getting the kind of size that you want?

MB: I go down to the lumberyard and I pick it out. Sometimes it's rough; it isn't sanded, you know. The wood is in the rough. It's usually in large boards. Heavy boards, rough boards. They come as much as eight- to ten-feet long.

Mrs. B: This is a rosewood piece here.

MB: That rosewood piece—I picked it up from the pile.

Mrs. B: Because he liked it.

MB: It happened to be a short piece, only five feet long, some are bigger. But what I learned is that I must carry some sandpaper with me out there, sand it up, and see what the color is like. Put a little water on there, and then I see what it's really like. But I already know approximately what this wood is going to be like from the books, the descriptions.

NH: Are the woods expensive?

MB: Well, yes, but it's not as expensive wholesale; they also sell those things to hobbyists retail and they're prohibitive. They charge them as much as $6 a square foot for ebony, for example, and they're 12 by 12 by ¼ inch. I don't pay anything like that.

Mrs. B: We have to buy a large quantity at one time.

MB: I pay less than a quarter of that.

NH: Do you buy large quantities?

MB: Yes. I have to buy at least 100 feet at a time.

Mrs. B: In other words, if he's going to spend less than $100, let's say, he can't do it, you know at a time.

NH: All this time, did you find that you were learning more and more about the woods? Or was your interest mostly in the texture and color? You took sandpaper along with you . . . did you find out anything else about the woods as you got into this more?

MB: No, except the technical side of it where I have to know which is really kiln dried or air dried, which is properly seasoned. If I didn't have properly seasoned wood, I'd get into trouble.

NH: Have you gotten into trouble?

MB: No, never, when they say it's kiln dried, it's kiln dried. In fact, most of the time, I can tell just by picking up a piece of wood, whether it's dry or not simply by the experience of how much it should weigh.

NH: Can you identify these woods botanically?

Mrs. B: We have the Latin names for all these.

NH: Do importers identify them that way when they sell them, or is that something you know?

MB: No, I don't think so. I suppose if you asked them, they might know. We have books that give

Continued on page 74

PERSUASIVE SCENTS

by Martin Birch

Female moths call for mating partners by releasing an irresistible scent that is operative for miles. Enticed by this attractant, males fly upwind until the seductress is located, but can only persuade her to submit by showering her with an extremely effective scent of their own. How sweet it is!

The human species takes immense care to remove all traces of natural body odors, only to replace them with perfumes derived from animal secretions intended to have the same effect as those so carefully removed. These artificial perfumes are usually supposed to make the wearer more attractive to the opposite sex. It is thought that early female *Homo sapiens* indicated their receptiveness to, or disinterest in, males partly through natural variations in body odor, and this may explain why today's females adorn themselves with more scent than males do. Correlated, perhaps, with a growing demand for sexual equality, perfume for men is becoming a booming industry.

When compared to the effect of scent on the sexual behavior of some insects, the vast resources invested by man in the perfume industry have an almost negligible effect on his sexual behavior. The female lure substance of a moth can entice males from miles around. Furthermore, the perfume emitted by the males of some species has to be 100 percent effective, since these males are only accepted by the female if they inundate her with scent.

The scents of male and female moths have, therefore, very different roles. The female's is primarily a long-range attractant, whereas the male's scent operates at close range to induce the female to mate, acting, in effect, as a sedative. Both belong to the class of secretions known to biologists as pheromones—derived from the Greek *pherein*, "to carry," and *horman*, "to excite." Pheromones are chemical substances secreted by an individual that trigger either behavioral or developmental sexual processes when perceived by other members of the same species. These are distinct from substances, such as defensive compounds, that are designed to affect members of another species—usually to deter would-be predators. Sex attractants released by female moths are carried downwind and perceived by males, which respond by flying upwind. Various types of chemical sex attractants occur widely throughout the animal kingdom, from planarian worms to primates. Males or females of almost all orders of insects employ sex attractant pheromones to bring the sexes together, to induce mating, and to deter other males from interfering with copulation.

When a moth such as the angle shades, *Phlogophora meticulosa*, emerges from the pupa, the wings must first of all inflate and harden. Females do not fly at this stage, but from the second night after emer-

Highly efficient structures that store and disseminate scent have evolved in the form of brushes in many species, including the male angle shades moth, Phlogophora meticulosa. *Contained in abdominal pockets, they are not normally visible.*

N MOTH SEX LIFE

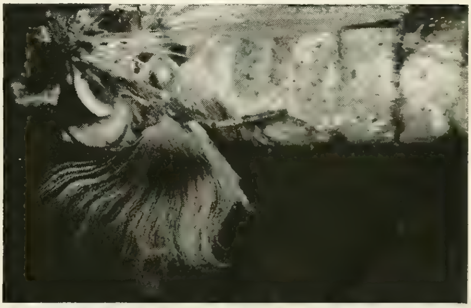
gence onward they usually release their sex attractant as a "call." Timing the release of the attractant is often critical for each species. In the angle shades this is about dawn in midsummer. Females call every day at the same time until they have mated two or three times—sometimes up to a maximum of seven matings. In other species, such as the silk moth, *Bombyx mori*, females stop calling as soon as they have mated once. Any sex attractant still on the gland surface or abdomen appears to be absorbed through the body wall and metabolized.

Because of the recent development of physicochemical techniques for the analysis of minute quantities of material, about a dozen female moth sex attractants have been identified to date. But the task is still very difficult. For example, Adolf Butenandt, the German biochemist, had to extract the pheromone from half a million virgin females of the silk moth to obtain 12 milligrams of pure chemical attractant. Most of the identified attractants are made up of large molecules, such as unsaturated alcohols and their esters and fatty acids, containing about 14 carbon atoms. Their similarity may be a result of the function they have to perform. The compound must be small enough to be manufactured without the expenditure of too much energy; it must be volatile, yet sufficiently stable so that it is not chemically changed in the air. Also, with higher molecular weights, more specific variation is possible.

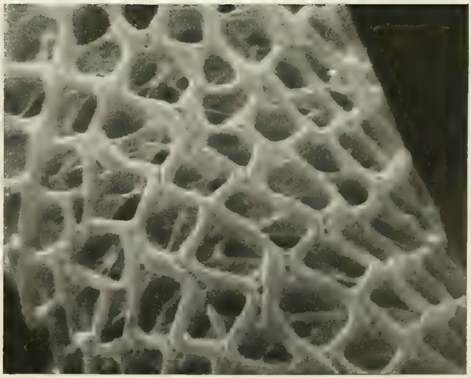
When these female sex attractants were first described, it seemed to biologists that the use of a different sex attractant by each species was the key process in species isolation. It is not that simple, however, as several species have now been found that respond to the same attractants. Thus, it now seems likely that other methods of species isolation are also important, such as different times for the release of the attractant and different emergence and activity periods. These factors then act in conjunction with the sex attractants to achieve the necessary reproductive isolation.

Male moths perceive the pheromone through a simple and effective system. While calling, the female rapidly vibrates her wings to create a current of air over the pheromone gland, thereby assisting evaporation of the secreted attractant. The pheromone then disperses and is carried downwind, eventually impinging on the antennae of a male of the same species. If stimulated by enough of the attractant, males respond by simply flying upwind, rather than by responding to the increased concentration gradient of female pheromone molecules. They continue to fly upwind as long as they can perceive the pheromone stimulation. However, as soon as the odor is lost, they alight or make frequent turns until they locate it again. Males can lose the scent by flying too far upwind past the female. When this happens, the usual method for precisely locating her is to alight as quickly as possible and search on either the ground, bushes, or trees, until tactile contact is made. Precise location of the female may be made by responding to her increased temperature as she vibrates her wings or by echolocation.

Detailed investigations over a number of years by Dietrich Schneider's laboratory in Germany have shown that 70 percent of the



The scent-laden brushes can be easily seen when a male specimen of the angle shades moth is inflated with air, everting the brushes from the abdominal pockets.



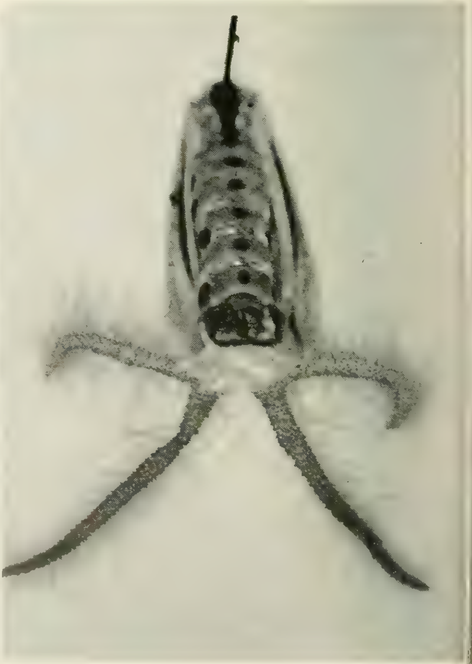
Magnified 7,000 times, a brush hair displays an intricate surface network that provides a large area for the storage of scent, as well as its dispersal.

receptor cells on the antennae of the male silk moth respond only to the female attractant. The antennae act as a molecular sieve absorbing over 30 percent of the sex attractant molecules passing through the antennal profile. Schneider's group has also demonstrated that at the threshold level of perception, 300 molecules striking the antennae are enough to elicit a positive behavioral response. The system is so sensitive that one molecule strike can stimulate a receptor cell and initiate an impulse to the brain. Thus the male apparatus of this species is certainly well adapted to react to calling females over long distances.

Turning to the scents secreted by the male moths, we find that, in contrast to female attractants, male scents are for the most part composed of small, volatile, and unstable molecules released very close to the female. Whereas female pheromones cannot be detected by humans, the scent of a single male moth often has a strong, detectable smell. At first sight, the variety of structures that have evolved to disseminate the scent appears almost limitless, but all the organs combine a glandular source of scent with eversible structures to disperse it. Scent brushes have evolved on the abdomen, thorax, and legs of many moths, and air-filled tubes, called coremata, occur almost as frequently. Some of this variety is demonstrated by the anterior abdominal brushes of the Noctuidae (a large family of night-flying moths that includes such destructive agricultural pests as the bollworm and the cotton leafworm) and the Sphingidae, or hawkmoths, both of different origin; and by the spectacular coremata of the Arctiidae, or tiger moths. Brushes connected with the genitalia are also common, an elaborate form of which are sported by the clouded silver moth.

Moths, which comprise the vast majority of Lepidoptera, show the greatest variety of male organs. Yet because the organs are normally kept concealed by the scales or in folds or pockets of cuticle, they have remained relatively unnoticed by generations of lepidopterists whose first wish has been to preserve, for their cabinet collections, fine, undamaged specimens with no scales missing. The brushes, however, can be displayed quite easily by simply squeezing the abdomen between finger and thumb. The increased internal pressure will then force out any brushes or coremata and also the genitalia. More satisfactorily, the everted organs can be displayed, and then preserved, by inflating the body with air through a fine tube and quickly drying the moth over a light bulb. With care, only a few scales are lost and the species is quite recognizable. This method requires a freshly killed moth.

All these structures are alike in being eversible and confined to the male and would seem to play an important role in courtship. The garden carpet moth, *Xanthorhoë fluctuata*, for example, and other species of this genus, such as the clouded silver, have extremely long coremata, which they readily use in courtship. Virgin females call by rhythmic protrusion of the attractant gland. A male attracted by this will fly to her, evert the coremata within one or two centimeters of her, and then proceed to copulate. In spite of their small size (two-centimeter wingspan), the coremata are easily seen on these moths in breeding cages as their striking white coloration stands out sharply against a black muslin lining. After eversion the coremata remain inflated for one or two seconds. Their volume can be twice that of the total volume of the moth, so we may suppose that the ventilatory current of air, necessary to supply the flight muscles with enough oxygen, is suddenly directed into the coremata at the critical time. It is easy to play a trick on the males of these carpet moths by separating a pair as soon as copulation starts, but be-



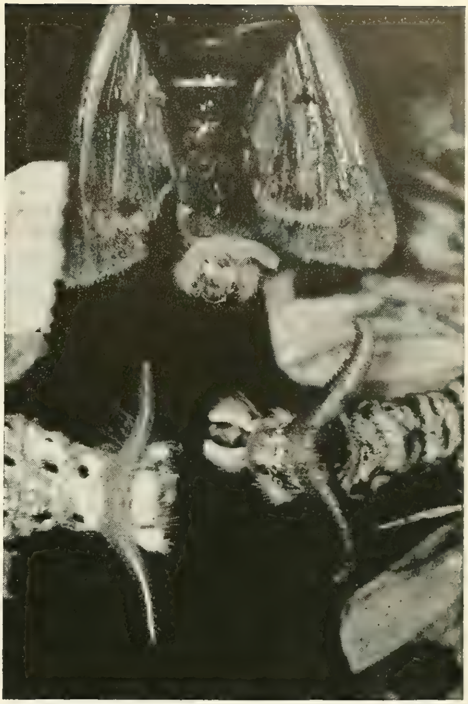
Tubelike organs, or coremata, support the scent-dispersing hairs of this male Malaysian moth, Creatonotus gangis. *When sufficiently close to a calling female, the male actuates the release of scent by inflating these tubes with air. Fully inflated, the coremata in this species reach more than three times body size.*

fore the male has had time to pass a spermatophore. He evidently still retains his mating drive and will still pursue and court many other calling females on the same night. Any pheromone originally present on the coremata is discharged on the first attempt, however, and is now exhausted so that the coremata have no more effect that night. A similar system of restricted scent operates in the Noctuidae.

In our investigations, we have looked at the brush organs of noctuid moths in much more detail. The attractive angle shades moth is typical of 150 other British Noctuidae in that it possesses large anterior abdominal brushes, many of which give off strong, distinctive odors. Their structure is rather more complex than that of the groups so far described. A pair of brushes is mounted at the tips of hardened sclerotized levers arising from the base of the abdomen. The levers are hinged about a basal sclerite, which can be moved by muscle action to swing the brush away from the body. The hairs are fanned out by muscles across the basal plate of the brush itself. At rest, the brushes are concealed in a pair of abdominal pockets extending halfway along the abdomen. Muscles along their lips open the pockets to release the hairs and to assist in replacing the hairs after eversion. In action, the brushes are suddenly flung away from the body and expanded by the coordinated contraction of all these muscles.

As with the other species described, female angle shades release a sex pheromone that initiates a series of responses in males: (1) Males fly upwind until they lose track of the pheromone-laden air and then cast about for the female; (2) they make contact using the antennae; (3) their pheromone-laden brushes then fan out very close to the female, and remain everted for only one or two seconds, followed immediately by (4), an attempt to copulate; (5) the female either accepts or rejects the male.

The everted coremata of tiger moths demonstrate the variety of scent organs that have evolved in different species. Top: the ruby tiger, **Phragmatobia fuliginosa.** *Left: the white ermine tiger,* **Spilosoma lubricipeda.** *Right: the Jersey tiger,* **Euplagia quadripunctaria.**



In a whole series of experiments, we found that females seldom refused males after the scent had been produced, but males were usually unsuccessful if we had previously removed the brushes or had anesthetized them and discharged any scent on the brushes. These scentless males only managed to mate with less discriminating females that had been calling for several nights without attracting a mate.

One interesting feature of this type of scent organ is that the scent-producing gland is active only in the later stages of the pupa. The secretion is stored within the gland until the moth emerges, then all the contents of the gland are discharged onto the brush and between the scales lining the pocket. The characteristic fruity smell of the angle shades' brush develops only after discharge from the glands and in conjunction with a secretion from the base of the pocket scales. The scent glands are not active again and actually degenerate, so that the male is provided with a finite amount of scent to last his adult life; enough, in fact, to charge the brushes three times with scent.

We can tell how many times females have mated by dissecting females caught in our light traps. Such females in flight are usually those that have finished mating and are flying to oviposit. A male passes one spermatophore, or sac, at one mating. This is stored in the female *bursa copulatrix* for later fertilization of the eggs, and a count of the number of spermatophores will reveal the number of times she has mated. The average number is two. Unlike males, females, are not restricted to three matings, and because some mate up to a maximum of seven times, others do not mate at all.

Under the high power of a scanning electron microscope, the surface of each of the brush hairs is seen to consist of an intricate network of ribs, somewhat like a sheet of expanded metal, with a less regular, spongy matrix beneath. All the noctuid species with this type of brush organ have similar surface structures differing only in the pattern of ribbing. In the angle shades it is an irregular diamond shape; in the wainscot moth, a regular repetition of diamonds; and in the dark arches moth, a regular hexagonal pattern like a honeycomb. Long before the advent of such sophisticated tools as the electron microscope, Fritz Müller in the late nineteenth century had said that "one could hardly find a more effective method of employing any odoriferous substance than that of saturating with it the hairs of a brush, and then suddenly opening them out in all directions so as to provide an enormous surface for evaporation." This is exactly how the noctuid brush works. In fact, the whole system is now seen to be much better adapted as an odor spray than Müller could have imagined. The sudden eversion of the brushes probably results in scent being shaken or flung off the hairs rather than evaporated. The huge surface area provides a large area for storage of scent while the brushes are in the pockets.

Several male scents have been identified. They are very unattractive to the human nose and would certainly not act as human aphrodisiacs. Compared with female attractants they are, as previously stated, much smaller, more volatile molecules. The "fruity" angle shades scent is a mixture of two monoterpenes and a simple carboxylic acid. Both terpenes are also known from ants where they are used as alarm pheromones in transmitting warning messages between the members of a colony. Of the other noctuid moths, three species of wainscot moths, genus *Leucania*, produce a mixture of benzaldehyde and *iso*-butyric acid. The scent smells of almonds to us as benzaldehyde comprises over 80 percent of the secretion. Butyric acid has a very unpleasant smell, like that of rancid butter for which it is also responsible. It crops up again as the normal isomer in the clouded silver moth of quite a different family, the Geometridae. Benzaldehyde also occurs in several other Noctuidae. The brushes of the dot moth are saturated with a mixture of benzaldehyde and phenyl ethanol. Closely related to it is the grey arches, which has both these compounds and also benzyl alcohol. The most complex compound so far identified is pinocarvone from the dark arches, *Apamea monoglypha*. It is related to camphor and smells rather like a mixture of camphor and menthol. Bark beetles also use the related pinenes, derived from their host trees, as pheromones for assembling and for mating stimuli.

The male moth compounds have much in common with each other. They are all small molecules released near the female in relatively large quantities. As our observations showed, their immediate function is equivalent to that of a sedative. So far there is no explanation of why certain Lepidoptera have evolved these sex scent systems while others have lost them, or why well over half the species have not evolved them at all.

One immediately attractive theory is that the male pheromones provide a species specific signal that prevents cross mating, particularly between species where the female sex attractants have been shown to be attractive to males of other species. However, three species of wainscot moth—the smoky wainscot (*Leucania impura*), common wainscot (*L. pallens*), and the brown-line bright-eye (*L. conigera*) —appear to have male scents that are identical (benzaldehyde/*iso*-butyric acid). How do the three coexist as separate species? All occur in the same locality, have similar life histories, eat the same food—a variety of common grasses—and emerge at the same time of year. Electrophysiological recordings from male antennae show that males of each species can at least perceive the female pheromones of the other two species as well as their own, although behavioral experiments have not been conducted to find out if they actually respond in this way in the field. The only observable difference comes from light trap catches, which indicate that each species flies at different, but overlapping, times of night. The smoky wainscot is the earliest flier, with a peak of activity about 10:00 P.M.; the common wainscot flies the latest, building up to a peak around dawn. Male flight activity often coincides with the release of female attractant, and these variations may indicate that the females have different calling times during the night. This method of species separation is not impossible. Detailed observations on the silk moths, Saturniidae, indicate that many species have the same attractant, but are separated by different calling times.

While the male scent may not be directly instrumental in species separation, it may affect the female directly by promoting oogenesis. It could stimulate release of the juvenile hormone that initiates yolk deposition, clearly an advantage if the final stages in egg formation are

A common woodland species in Britain, the male clouded silver moth, Bapta temerata, *has elaborate scent brushes associated with its genitalia.*

triggered by a stimulus received when the sperm are transferred.

Also, the release of male scent at the start of copulation may repel other males more effectively than the mere cessation of the female scent. Certainly the male scents are in many ways very like defensive substances. Both are released in large quantities close to the target animal and possess an unpleasant smell to other animals, in contrast to the properties of female sex attractants. Indeed, in the hawkmoth family, Sphingidae, males have brushes that are everted as part of a defensive display when attacked by predators.

One possible explanation of how the system of male brushes may have evolved was originally put forward by Miriam Rothschild. She pointed out that any character that fulfills a double function has a better chance of selection and evolution than one possessing a single beneficial attribute. She suggested that insect attractants and courtship scents first evolved in connection with the scents of their food plants, thus linking flowers and their pollinators in time and space. Their role as courtship pheromones would have developed subsequently. From there it would only be a short step to boosting the odors produced by scent brushes so that they could function as both courtship scents and as deterrents to other species.

On the other hand, it is just as likely that male scents were originally selected as deterrents, and that hawkmoth brushes are now at this stage of development. Simple experiments, such as removing the brushes of newly emerged males or gluing them into their pleural folds, proved that the brushes are not used in mating. It thus seems that their role in the defensive display is their main function, but this suggestion implies that males are more likely than females to be attacked by predators.

For many species of moths, if not for all animals, one of the most vulnerable periods of their lives is when they are copulating. In those species that can copulate aloft, flight is likely to be clumsy. Copulation is one time when there would be no need for both sexes to provide defenses, explaining the puzzle of a supposed defensive organ confined to one sex.

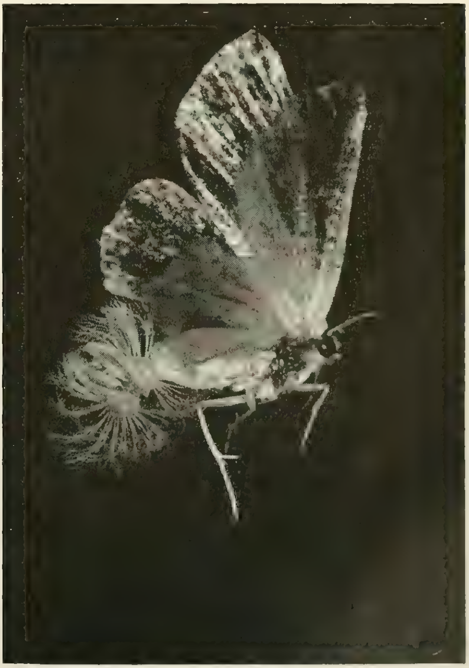
Since it seems likely that potential predators would learn to respond either directly to the scent of a calling female or to the males converging towards her, the scent may be designed to deter small mammals, particularly the night active bats, which can take moths both in flight and from the ground. By day, when birds become active, copulation has usually terminated and both sexes are mostly hidden. If the scent does, in fact, act against nocturnal predators, selection would soon favor females mating with males that produced a predator repellent, since females mating with other males would tend to be eliminated. The system can be traced through to the Noctuidae where the female only mates with scent-producing males.

Of course, this is pure speculation. Although the male scents are undoubtedly unpleasant to one mammalian predator, namely man, this is hardly evidence that they repel other predators, nor do we know if the scents are persistent enough to last the duration of copulation without evaporating.

Also difficult to explain is the evidence that many species have secondarily lost their brush organs, as appears from the numerous vestigial organs in the Noctuidae. Clearly there are some exciting questions waiting to be solved by research.

Our over-all picture is that male brushes and coremata are very plastic structures. Within the thirty or so species of British tiger moths, brushes or coremata have evolved independently at least eight times. A detailed investigation of the Noctuidae shows us that the lever and

Continued on page 72



The scent, or pheromone, carried on the brushes of the male clouded silver moth is composed of butyric acid. Discharged over the female as a prelude to copulation, it may also serve as a means of species identification.

The American Lion

by Maurice G. Hornocker

Alive and well, this mystery-shrouded cat roams the rugged mountain fastnesses of Idaho

The mountain lion is the prince of Western Hemisphere predators. Naturalist Ernest Thompson Seton described the lion as "lithe and splendid beasthood. His daily routine is a march of stirring athletic events that not another creature—in America, at least—can hope to equal." Capable of living in habitats ranging from tropical jungles to deserts to subalpine types, the lion (*Felis concolor*) can exist exclusively on a diet of small rodents or elk. Ultrasecretive, this splendid cat shuns proximity to man and inhabits rugged, inaccessible wilderness country.

The American lion is perhaps the most mysterious and misunderstood of all the world's large carnivores. This is evident from the many names applied to this great cat throughout its range—puma, painter, cougar, panther, catamount, leone. Most adaptable of all the large cats, it once had the widest distribution of any mammal in the Western Hemisphere, and perhaps in the world. It ranged over both American continents, from the east to the west coast of North America and from central British Columbia south to Patagonia. Authentic records of mountain lions are available from 47 of the 48 conterminous states and the District of Columbia. As the white man populated North America, lions vanished from much of their range. They now live in sizable numbers only in the western and southwestern states, in Central and South America, and in parts of British Columbia and Alberta. A population of undetermined size exists in the Florida Everglades, and recent information suggests there are lions in eastern Canada.

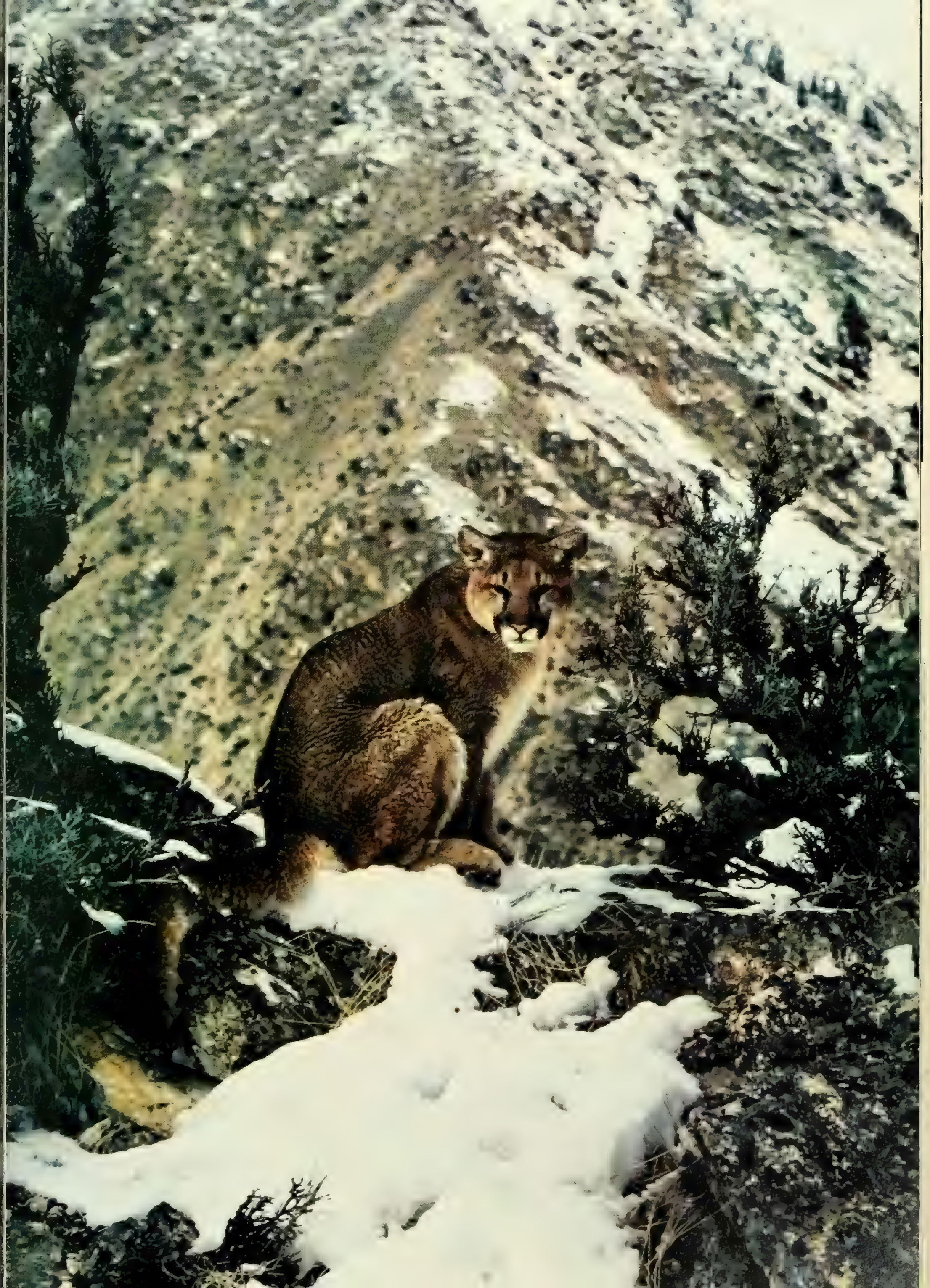
Because of emotionalism regarding large predators, a wealth of misinformation has accumulated on the mountain lion. Theodore Roosevelt spoke of the "big horse-killing cat, the destroyer of the deer, the lord of stealthy murder. . . ." Many others have written of the lion's presumed insatiable taste for destruction, of its bloodthirsty lust for killing. Lions do sometimes kill domestic stock, thereby strengthening man's intolerance toward them. As a result, indiscriminate killing of the mountain lion, often encouraged by bounties, has been the rule.

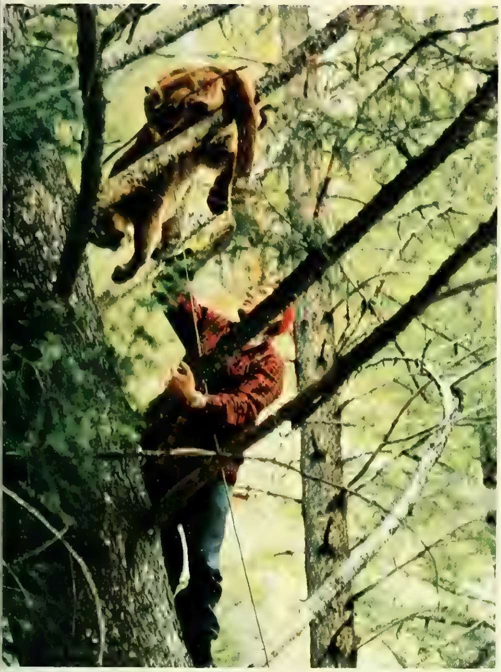
That lions kill other animals, some of them, such as deer, of special interest to hunters, is a fact; but the effect of this killing on populations had never been assessed objectively. Nor had the dynamics of a population of lions ever been studied: its density, productivity, fertility, mortality, and range and space requirements. It was obvious that to preserve this species, and those animals upon which it preys, a thorough investigation was needed.

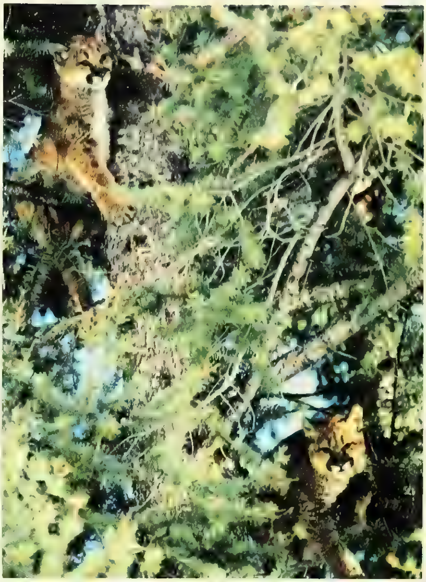
For the past six years, I have been trying to find answers to some of these questions in the rugged wilderness of central Idaho. My study area encompassed 200 square miles in the Big Creek drainage basin in the center of the $1\frac{1}{4}$-million-acre Idaho Primitive Area. I chose this splendid country for several reasons. According to diaries of settlers in the mid-1800's and government records in the early 1900's the region was a stronghold for the mountain lion. More recently, bounty records and sportsmen's kill figures indicated that sufficient lions occurred there to obtain adequate quantitative data.

Big game, mainly mule deer and elk, also were abundant and during winter months were confined to a relatively small sector of their total range. Deep snow drives game animals to the lower elevations along major stream courses. Lions also seek these lower elevations and thus were more available for study and

A lion sits on a ridge, whe
he can survey the remo
Salmon River country. Wh
winter snow drives mule de
and elk into the valley
mountain lions follow them dow







To determine the
whereabouts and
ondition of the lions,
trained hounds are
set out on trails.
When the dogs tree
cats, such as the two
tens, upper right, the
lions are shot with a
lative, lowered to the
ground, marked,
weighed, and then
released to the wild.

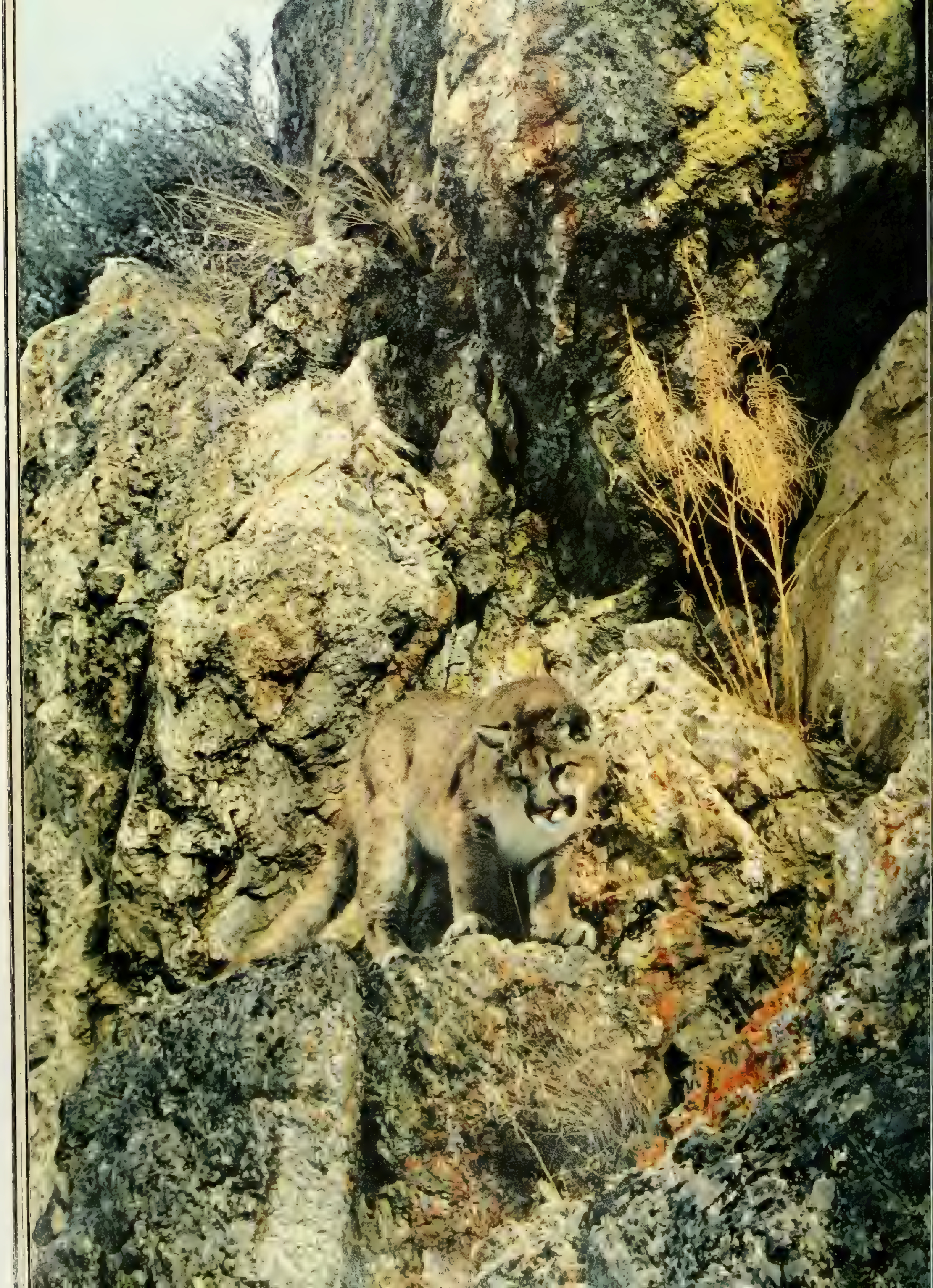
capture. Because of the difficulty of working in summer, when the animals move up to higher elevations and range over a much larger area, I did most of my research during the winter and spring, from November to May.

I had two objectives: to study the dynamics of the lion population and to assess its impact on big game. I suspect mountain lions have spent many more hours watching me than I have spent minutes observing them. Although I studied them for six years and spent months in their remote mountain sanctuaries, I rarely got more than a glimpse of a free-roving lion—and then it was usually because he had seen me and was moving away. Therefore, to study them I had to capture and individually mark each lion so it could be identified. Then, by tracking them in the snow and by repeatedly recapturing individuals every season and over the years, I gathered a fund of information on each individual and, ultimately, on the population. I hired Wilbur Wiles, a long-time resident of the Primitive Area and a veteran lion hunter, to assist me. His trained hounds were used throughout the study to tree lions, which were then immobilized with drugs, marked, and recorded. After this, each was released, unharmed, back into the wild.

We have, over the six-year period, captured, -marked, and released 51 different lions, 44 of them in the Big Creek study area. Thirty-six of these were recaptured in subsequent years, many of them 15 times. We caught one male 20 times. In all, we made 173 captures of lions and tracked them in the snow for literally hundreds of miles. These capture–recapture data, the events interpreted from tracks, and the information gained from the return of tags from lions killed by hunters give us a good picture of the lion's population status and ecology.

The lion population was stable, with no more than ten adults as full-time winter residents of the 200-square mile study area. Of the other lions we captured, 29 were kittens and 12 were transient adults. Every year two litters, numbering two or three kittens each,

Crouched low in the spring grass, a lion is nearly hidden as he stalks prey. Although lions eat a wide range of food, including grasshoppers, their main winter diet consists of elk, below, and mule deer, bottom.



were born, except in 1969 when we recorded only one litter.

The resident adults had firmly established territories. Each lion confined itself to a definite range. Females shared some areas but males appeared to maintain rigid boundaries between territories. The size of the females' winter home range varied from 5 to 25 square miles; males utilized an area of 15 to 30 square miles. These are minimum home ranges based on capture–recapture data; I believe some lions actually use larger areas.

Territoriality appeared to be the primary factor regulating the number of lions in our study area. The number of adults well established on territories remained unchanged from year to year despite the birth of four to six kittens into the population each year. After becoming self-sufficient at about 18 to 20 months of age, young lions all left the area; none of the offspring of resident females was captured on the study area beyond its second winter.

Further evidence of strong territoriality was the movement each winter of additional lions—practically all young—into the study area, but none stayed. I believe they recognized that they were in the established territory of another lion. The resident animal never forcibly evicted these transients, and tracks indicated they avoided contact.

Different individuals used the same areas but never at the same time—lions were spaced in time as well as area. Scrapes or scratch marks appear important in this spacing, as well as in the establishment of territorial rights. Lions scrape leaves, twigs, fir needles, or sometimes, snow into small mounds and frequently urinate or defecate on top of them, making an olfactory as well as a visual mark. These marks inform other lions that one is already in the area, how recently he was there, and perhaps even which individual made the mark.

untain lions are able to
de man partly because of
ir protective coloring,
ich here blends with the
hen-covered rocks.

All lions, but especially males, make these marks on trails, on high ridges, and at lion crossings; some permanent marking stations occur in each territory. Both males and females visit these sites. Ordinarily they follow an accustomed route, whether hunting or seemingly just traveling. On a number of occasions an animal tracked to one of these sites abruptly changed course, sometimes retracing its route for a considerable distance. Invariably we found another lion or family of lions in the area.

I believe this behavior, which I call mutual avoidance, is necessary for the survival of solitary, specialized predators. A solitary predator depends on its physical well-being to survive. Consequently, unlike gregarious species such as wolves, lions cannot afford the luxury of fighting in defense of a territory. An injured wolf may survive as a member of a pack; an injured lion probably would starve. The mutual avoidance mechanism appears to have evolved as a nondamaging means of spacing solitary lions.

Mountain lions, like certain other carnivores, appear to limit their own numbers and thus maintain a balance with their prey reserves. Cannibalism is an extreme manifestation of this self-limiting mechanism. In February, 1966, we documented this for an adult male. Turning the dogs loose on the single track of a kitten, we soon found that this track merged with others—two other kittens, an adult that we assumed was the mother, and a large male. The hounds soon broke out in frenzied baying, indicating they had treed one or more lions. We reached the dogs after a 30-minute climb up a mountainside. We found they had two lions treed: a large male, No. 18, and No. 16, the mother of the kittens. Circling the area we found the remains of two kittens and the tracks of a third that had escaped down the slope.

By tracking and backtracking, we unraveled the story, distinctly spelled out in the snow. The male had entered the canyon area where the female had left three kittens while she hunted. He killed and ate two of the 50-pound kittens; the other, whose tracks we had first seen, had escaped. The female returned and apparently attacked the marauding male, but to no avail. The newness of the snow indicated that lions, hounds, and men all arrived on the scene within twelve hours of each other.

Not all adult male lions practice cannibalism, however, and many males and females with families inhabit the same territory without conflicts. Cannibalism is an "internal" population control mechanism, which is common to the large predators, and which seems to operate when other checks are not effective. It is probably essential to the survival of the species.

During the six-year period, five females produced ten litters for a total of 25 kittens. Three of the five females produced offspring at a two-year interval, information is incomplete for one female, and the other produced three litters in slightly over five years. All kittens, with the exception of one litter in early November, were born in spring or early summer. One litter of two males became self-sufficient when slightly more than a year old; all other offspring remained with the female until they were approximately twenty months of age.

Young lions remain dependent on the lioness for a long period. While they possess certain inherent abilities, they must learn to hunt the various kinds of prey. They must also learn killing techniques, which are crucial for such large prey as deer and elk. The first few weeks after becoming self-sufficient are probably critical in a lion's life. Some young lions have difficulty stalking large animals or are inept at killing them after a successful stalk. We saw, from tracks in the snow, several instances where inexperienced lions had trouble bringing down young deer. Such individuals must rely to a greater ex-

Continued on page 68

Sky Reporter

Runaway Stars and Pulsars In our galaxy, most hot blue stars occur in binary systems near the galactic plane. They depart very little from their normal circular motion in the revolving galaxy. Some, however, are streaking away from the galactic plane at speeds of 50 miles a second or more.

Astronomers generally believe that these "runaway" stars were once members of pairs in or near the galactic plane. They were released when their companions blew up and suddenly ceased to exert the gravitational pull that had kept the runaway star in a tight orbit around its partner. The concept is similar to that of the hammer throw at a track and field meet. A man spins around as he swings a weight. When he releases it, the weight moves off in a straight line at the speed at which it had been moving in a circle.

Binary stars present an interesting variation, however. The star that explodes loses so much mass that its remnant is dragged along in the wake of the runaway star. In the mid-1960's astronomers searched for these remnants without success. Now they believe they know what they look like and believe they have found at least 50 of them. They know them as pulsars.

The evidence was marshaled in *Astrophysical Journal Letters* recently by J. Richard Gott III, James E. Gunn, and Jeremiah P. Ostriker, who worked on it when they were at Princeton University Observatory.

They show that most pulsars found near the galactic plane blink rapidly, while those farther away are slower. Pulsars are believed to slow down as they age. The newer ones are still near the plane; the older ones have moved away from it.

They point out that the famous pulsar in the Crab Nebula, NP0532, is going 60 miles a second, as fast as a runaway star. Another pulsar, NP0527, is just outside the nebula. NP0532 has the shortest-known period; NP0527, the longest. The authors propose that both were once binary stars revolving around each other in the constellation Gemini. Three million years ago the star that became NP0527 blew up; its companion flew off in the direction of the constellation Taurus, dragging NP0527 with it. Then, in 1054, the companion also exploded, leaving as its remnant NP0532.

The Princeton group offered predictions on how fast NP0527 should be slowing down and what its apparent motion relative to the background stars should be if their hypothesis is correct. They also suggest that all pulsars be checked to see if they are moving at speeds typical of runaway stars.

Shuddering Moon Every 28 days, when it comes closest to the earth, the moon apparently bulges enough to crack and quake for nearly an hour. The gravitation of the earth causes a tide in the solid surface of the moon, similar in kind and cause to the tides the moon raises in earth's oceans and, to a much lesser extent, in the shape of the solid earth.

The monthly shudder causes "moonquakes" strong enough to register on the seismometer left on the moon by the Apollo 12 astronauts just a year ago. Of the 160 signals received from the seismometer in the first seven months, 14 occurred when the moon was at perigee, some 30,000 miles closer to the earth than it is at apogee. The quake signals came in pairs, one just at the time of perigee and the other a day or two later, apparently as the moon settled back to its former shape.

Gary Latham, the Columbia University seismologist in charge of the experiment, has suggested that the quakes may be severe enough to release gases trapped under the lunar surface. These emissions could account for the widely reported "transient lunar phenomena"—momentary patches of color, usually red, seen obscuring lunar features from time to time.

The hilly region around the crater Fra Mauro, where the Apollo 14 astronauts are scheduled to land next year, may be the center of moonquake activity, according to Latham. Professional and amateur astronomers have been asked to concentrate their watch for transient lunar phenomena in this region, particularly around the time of perigee each month.

A Clean Bill of Health Before men first stepped on the moon, there was a very real fear that they might bring back alien organisms that would wreak havoc on earth. Returning astronauts, and the samples they brought back, were quarantined and rigidly tested.

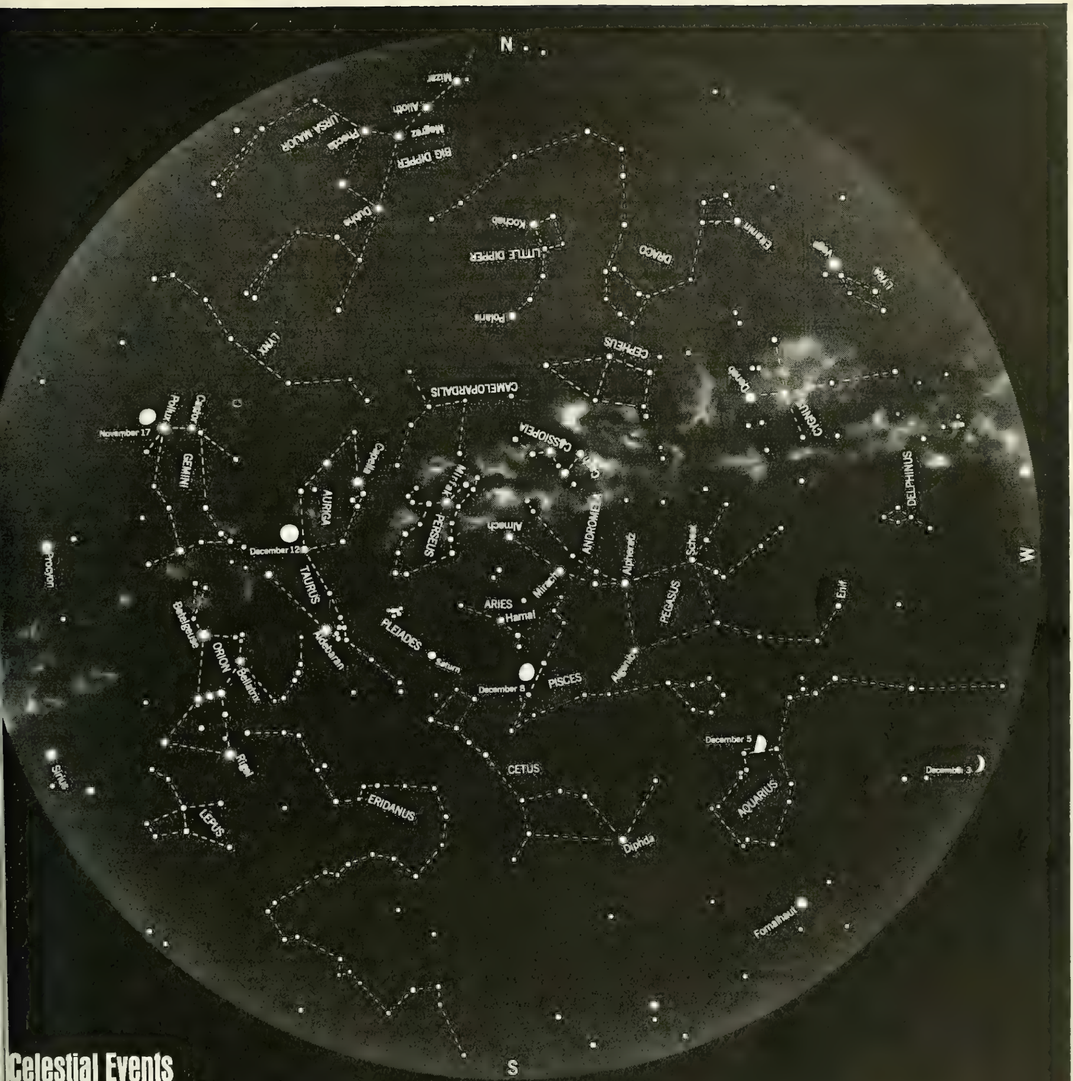
In one test, ten species of lower animals were exposed to lunar material by contact and even ingestion. The 14-man team reported happily in *Science* last summer that their search for an "Andromeda Strain" had proved fruitless. Many of the individuals of one species did die, but the team found no evidence that the lunar samples had played any part. They concluded: "No pathological effects or evidence of the presence of replicating organisms were detected in any of the exposed experimental animals."

No changes were observed in two species of protozoans. Planarian worms also were unaffected, but the team noted that worms in a bowl treated with sterilized lunar material spent more time swimming on the surface of the water than did their counterparts. German cockroaches, which ate some of the sample, showed no damage to their gut from the glass beads that comprised much of the sample. No changes were found among houseflies, while greater wax moths showed a slightly higher, but statistically insignificant, survival rate.

Brown shrimp and freshwater and saltwater minnows showed no changes, either during the 28-day test period or in autopsies of selected individuals. Only oysters raised a question: many died during the test period. The scientists concluded, however, that exposure to lunar samples was not the cause. They pointed out that the tests occurred during the spawning season and that many of the animals were in poor condition. Postmortems showed nothing related to the lunar material.

At this point the moon looks pretty safe. Mars, if man decides to go there, is another question.

John P. Wiley, Jr.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Mizar
Alioth
URSA MAJOR
Phecda
Megrez
BIG DIPPER
Dubhe
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LITTLE DIPPER
DRACO
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Vega
LYRA
Polaris
LYNX
CEPHEUS
CAMELOPARDALIS
Deneb
CYGNUS
November 17
Pollux
Castor
GEMINI
Capella
CASSIOPEIA
DELPHINUS
AURIGA
Mirfak
PERSEUS
Almach
ANDROMEDA
Alpheratz
Scheat
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Procyon
December 12
TAURUS
Mirach
ARIES
Hamal
PEGASUS
Enif
Betelgeuse
ORION
Bellatrix
Aldebaran
PLEIADES
Saturn
December 8
PISCES
Markab
December 5
December 3
Rigel
Sirius
CETUS
ERIDANUS
AQUARIUS
LEPUS
Diphda
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S

Celestial Events

The moon is in the morning sky in late November, with last-quarter on the 20th and new moon on the 28th. The evening crescent appears in the first week of December. First-quarter is on the 5th and full moon on the 12th.

Venus, Mars, and Jupiter are all morning stars in late November and early December. Saturn is in the sky most of the night: rising in the early evening, setting during morning hours. Mercury, an evening star, is not well placed for observing.

November 17: The Leonid meteor shower, which produced a spectacular display in the western United States during 1966, reaches maximum. Though moonlight will brighten the after-midnight sky, the shower sometimes produces very bright obects.

November 24: Mars, in the morning sky, has been moving to he left toward the bright star Spica, in Virgo. They are nearest one another this morning.

November 25: The reddish star near the rising crescent moon this morning is Mars. The star Spica, brighter than Mars, is nearby.

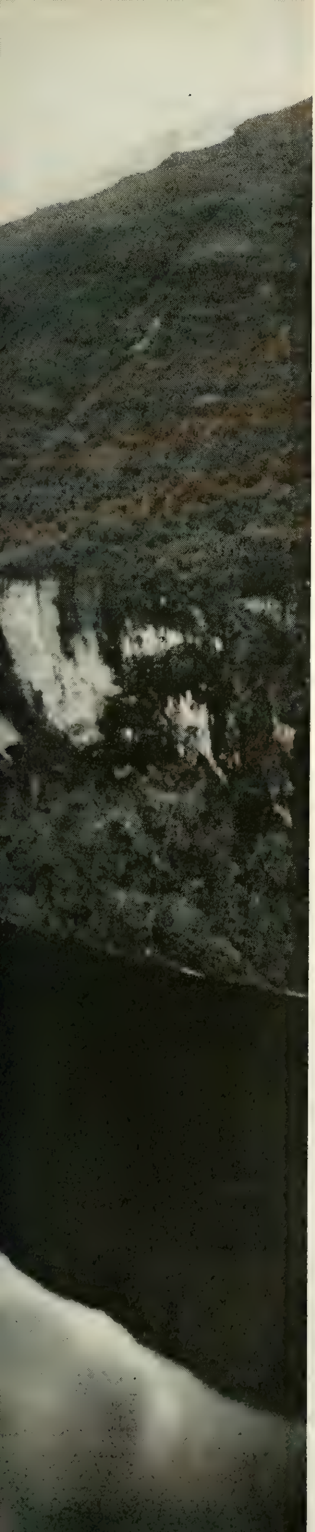
December 9-10: The bright object near the moon is Saturn. The moon will move closer to the planet during the night, and appear closest by dawn.

December 10: Mercury is at greatest elongation in the evening sky. The planet is less than ten degrees above the horizon at sunset, however.

December 14: Maximum of the Geminid meteor shower, producing about 50 meteors per hour per observer, occurs this morning. A bright gibbous moon, however, makes observing difficult.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:20 P.M. on November 15; 9:20 P.M. on December 1; and 8:25 P.M. on December 15; but it can be used for about an hour before and after those times.



BENTHIC LIFE IN THE FJORDS OF NORWAY

by Michael Berrill

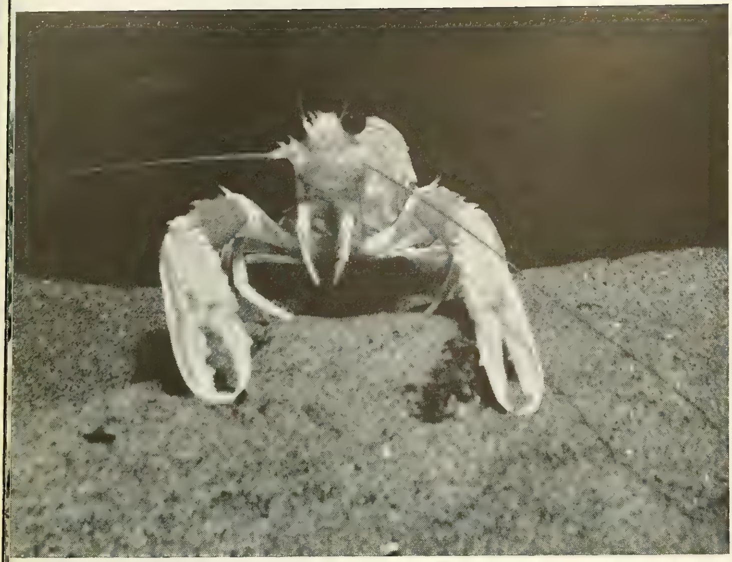
The deeper parts of the ocean generally lie far from continental shorelines, so most of what we know about life there has been observed on ships at sea. Some benthic animals are collected by expeditions, but because ships are small and expeditions short of time, the animals are quickly preserved and rarely observed alive for long. As a result, we know which animals inhabit deepwater sea floors, but are ignorant of how they actually go about living in their dark and pressurized environment.

Occasionally, however, moderately deep water, together with its strange fauna, is found close to shore. Ocean depths penetrate Norway, for instance, in fjords, modifying a land and a people in the process, and bringing the usually inaccessible animals tantalizingly near. And so for a month in Norwegian summer sunshine I hauled nets full of animals up to the surface, observed some briefly, and kept others living for days and weeks, gradually learning a little about the benthic community of a Norwegian fjord.

The fjords that have made Norway so special were carved by ice and time. About 10,000 years ago the last Ice Age withdrew and released Norway from the glaciers that had covered it with ice as much as two miles thick. New land emerged from under the ice or out of the sea, new coasts limited it, and new islands modified its coastal waters.

The nature of this land of Norway, which rose unevenly from its glacial covering, is itself a product of the ice. In preglacial times. rivers flowed down from the Norwegian plateau, often along fault lines, and the relentless, scouring glaciers that followed molded these fault lines into deep, U-shaped valleys. The shores of Norway, then, are ice-scraped shores, and its fjords are valleys that were once glaciated and are now submerged.

The fjords reach far into Nor-



Much slenderer than the American species, the Norway lobster, *Nephrops norvegicus*, fights as belligerently as its menacing appearance suggests.

way, sometimes more than 100 miles, meeting their tributaries amid steep mountains and plunging waterfalls. Sognefjord, for example, the longest and deepest, is over 4,000 feet deep at its mouth. This is far greater than the 500- to 600-foot depths that characterize the inner portions of the continental shelves extending around most large land masses. The bottom-living animals of the fjords are much the same as those that live in deeper water many miles from land, but in the fjords the animals are only a mile or two offshore, and the water is calm and easy to work from.

I lived beside, and collected from, Raunefjord, southwest of Bergen, which is more exposed and not as deep as Sognefjord. It is a fjord half-surrounded by large, barren islands and interspersed with smaller ones known as skerries. About 150,000 such islands make up what the Norwegians call the *skjaergard*. Helped by staff members of the biological station at the University of Bergen, I hauled animals up from depths of 800 feet or more and took them back to the station on the edge of the fjord, where I observed and photographed them in aquariums that I had made as natural as possible.

We collected the benthic animals from the *Fridtjof Nansen*, a vessel named for the famed polar explorer. Each day that we went out we dropped an otter trawl and dragged it along, picking up those animals that were on, or just above, the bottom surface, but not catching anything that burrowed deeply.

It wasn't particularly difficult work, but it was slow. The trawling net—wide-meshed, with glass balls along its upper edge—was attached to the end of about a mile of cable. It took us at least half an hour to drop the net, and another hour to pull it back up and clean it in the surface water. A winch did all the work, but still we could not expect to drag the bottom more than two or three times a day. And we never knew until we had the net and its catch on board whether we had caught anything special or, for that matter, anything at all.

Trawling in August proved to be a lesson in frustration, for day after day the sun shone, warming the surface water until it was comfortable enough for swimming—and lethal for those animals coming up in the net from the cold of the bottom.

The fjord bottom is constantly, unvaryingly cold, about 42° to 43° F., and it is muddy. In order to wash some of the mud from the net we had to drag it around in the surface water for at least twenty minutes, and few animals can tolerate such a sudden and prolonged increase in temperature. Time after time we dumped a netful of animals on deck, and time after time I found some species were always

dead, some dying, some weak, and some still healthy. All the living animals were put into a huge cold tank in hopes that enough would recover so that I could observe them and, over the weeks, many did.

I had never seen living deepwater animals before I visited Raunefjord, so each one was something new to fit into a general picture of the benthic community. Most of the species that invariably died from exposure to the warm water and decreased pressure were fish. They were the main predators of the community, foraging over it to feed on other animals that did not hide or defend themselves successfully.

Numerous crustaceans, including shrimps, crabs, and lobsters, walked about on the mud also foraging for food; but these were mainly scavengers, searching for dead or weak animals. Some animals, such as sea cucumbers and worms, lived on the mud surface or burrowed under it and ate the mud, digesting any food it might contain. Others, such as sea anemones, sat quite still, often mostly buried in the mud, filtering the water around them for its detritus and small organisms. And some buried themselves or walked about, filtering the water, eating mud, or scavenging, all depending upon the circumstances.

As species after species was collected and put into the aquariums, I was more and more struck by what is probably the most obvious feature of these benthic animals: most of them are red. Sea anemones and sea cucumbers, shrimps and lobsters—even a species or two of fish—all had exposed or dorsal surfaces that were not only red but often seemed to be the same shade of red. I had heard that this was true of many deepwater benthic animals, but I had no idea of how widespread and consistent the redness actually was.

However, while these animals appear red at the water's surface, they look black in their deepwater habitat. As water gets deeper, it progressively absorbs the longer wavelengths of light. Red and orange are the first to go and are virtually absent below a depth of 100 feet, causing red objects to appear black.

The similarity of red coloration, embracing animals that bear no visual relationship to one another, can be attributed primarily to dietary factors. The basic food source of much of this benthic community are the deepwater planktonic animals,

A northern shrimp, *Pandalus borealis,* right, pirouettes across an observation tank as squat lobsters, *Munida sarsi,* engage in threat behavior, below left. If molested, the sea cucumber, *Stichopus tremulans,* below, will expel its intestines through the anus.

which contain high concentrations of red pigment in the form of carotenoids. Also, in the dim light and black mud of the benthic world, red probably serves a protective function, for it matches the color of the substrate on which these animals live.

I wanted to concentrate my efforts on one species of the community, one I could watch in its own world. For this I needed an easily caught species that could survive the warm bath in the surface water. I also wanted it to be a species that would be interesting to experiment with, not one that would sit around inactively. So I searched for an animal that was abundant, tolerant, and active.

The only well-known animal that I caught was the large, translucent red shrimp, *Pandalus borealis*, the shrimp that most of us eat. It is also the shrimp that started people trawling the coastal waters of the North Atlantic in search of its schools, and so it has indirectly led us to a host of other animals we normally would not see. The schools of *P. borealis* are large when they are found, but they don't always turn up when and where expected. They also may not be as common as they once were.

This shrimp was certainly abundant in Raunefjord, and although only 10 or 20 percent of those I caught lived, there were enough for me to work with. I had expected the shrimp to school actively, even in captivity, and I hoped to discover what kept the members of such a school together in a world as dim as theirs. So what did my captives do? They mostly sat on the bottom and sometimes walked about on it, but I could not induce them to school.

I observed other species of shrimp, as delicate and colorful as *Pandalus borealis*, but far less common, and they also spent their time stalking about on the mud, refusing to school. The large crabs I had under scrutiny scavenged and intimidated just about everything capable of sensing their presence. Several Norway lobsters, *Nephrops norvegicus*, fought belligerently whenever they met, and never left each other alone long enough to dig their customary shallow burrows. But I didn't catch enough of these animals to do more than observe them casually, hardy and active though they were.

The most tolerant and abundant animal I caught was *Stichopus tremulans*, a sea cucumber whose dorsal side was even redder than most of its benthic neighbors. Some succeeded in making it up to the surface in the trawl even when the net had not opened properly or when nothing else was captured, and when most other animals died from exposure, *S. tremulans* lived. Unfortunately, like most sea cucumbers, these were not exactly the most exciting animals to watch as they lay eating the mud in their aquariums, doing little more than look colorful.

They did have one ability, however, that may partially explain their abundance and sluggish, exposed behavior. When I molested one, it simply expelled its intestines, forcing them out through its anus. Had I been a fish, presumably I would have eaten this mass of intestines and gone on my way, not bothering with the leathery, tasteless bag that had contained it. Yet that empty bag is perfectly capable of growing a whole new gut, even if it takes a year to do so, and at the cold temperatures that *Stichopus tremulans* inhabits, it might well take that long.

Another sea cucumber, *Bathyplotes natans*, was as rare as *Stichopus tremulans* was common. Pink and somewhat flat and fleshy, it convinced me that not all sea cucumbers just creep around and eat mud. This one could swim. The evening after I caught my only specimen, it swam around the aquarium for an hour or two, and its flatness and fleshiness seemed to be adaptations for making it more buoyant. It swam by undulating its body up and down, rather than sideways as fish do. I have heard that fishermen have caught this swimming sea cucumber at virtually all levels off the bottom, and so I expect that the one I caught was an intermittent visitor to the benthic community.

Just as tantalizing as finding this one swimming sea cucumber was finding several individuals each of *Rossia macrostoma* and *R. glaucopis*, small species of the cephalopod family that includes the squids and cuttlefish. They arrived on board ship very weak and lived only long enough to assure me that they were as fascinating as they looked. As the various members of this genus are almost always deep-water animals, no one knows much about them other than that they often bury themselves in the mud. They are blunt-ended little animals, rarely more than several inches long and very different from their larger, streamlined relatives. Like the fish that swim over the bottom, *Rossia* are predators of the various animals living in and on the mud. And because of their small size, they are, in turn, a common source of food for the larger fish. I saw none of their natural behavior, for the ones I caught simply flashed their chromatophores and swam around for a few minutes before settling down and quietly expiring.

Even though the shrimp didn't school, the little cephalopods didn't live, and I didn't catch enough lobsters or swimming sea cucumbers to work with, I did find an active and aggressive crustacean that was both hardy and relatively abundant, and whose behavior no one seemed to know much about.

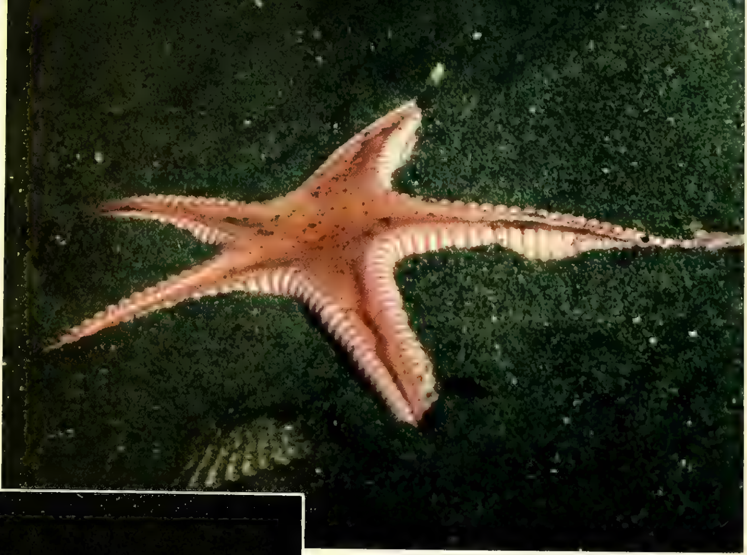
It was a crustacean of the group known as the galatheids, which are something like a cross between a shrimp and a crab, and somewhat distantly akin to hermit crabs. This animal was *Munida sarsi* and like a crab, its tail was turned under its thorax; but like a shrimp, its body was longer than it was wide. It also tended to walk forward, not sideways, and exhibited the usual shade of red on top with white underneath. Its first pair of legs were long claws reaching way out in front of the body, the kind of claws that typify reptant crustaceans, which walk about on sea bottoms everywhere.

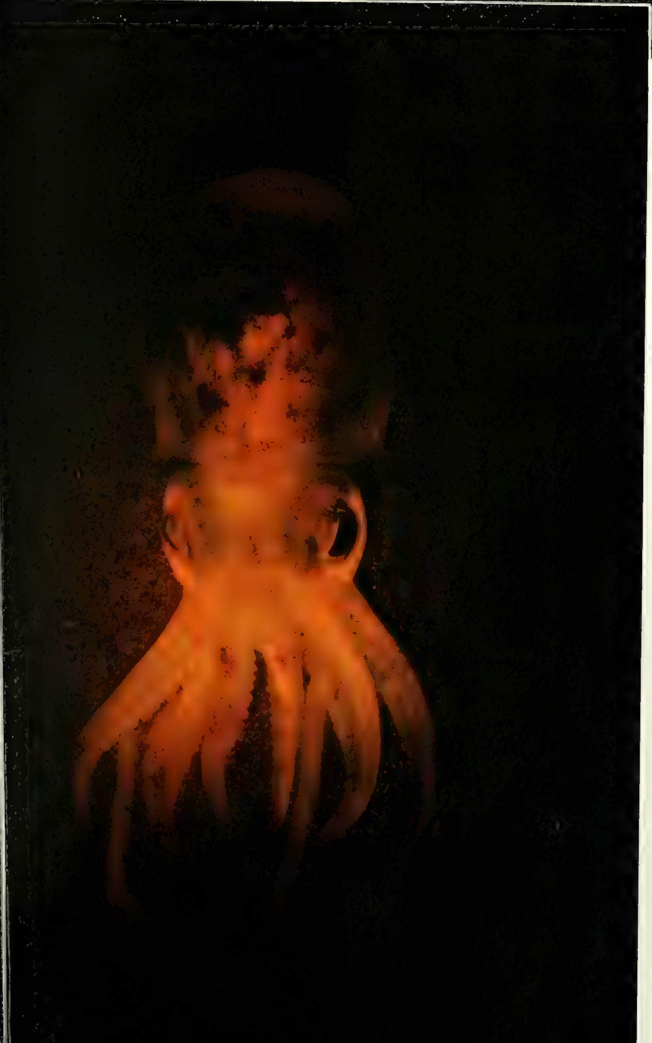
Although most reptants are scavengers, foraging for their food and feasting on dead companions, *Munida sarsi*, like so many of its community, is a mud-eater. This it does by picking up bits with the pincers on the large claws and also by scraping its walking legs through the mud and cleaning them off in mouthparts modified for this purpose as well as for filtering particles of food from the water. Moreover, its thin, prehensile hind legs roam all over its body, picking and cleaning everything from legs, eyes, and antennae, even to the inside surface of its carapace. After a stint of such cleaning, each of these legs always reaches to the mouthparts to be cleaned in turn, giving the animal yet another source of food.

The three pairs of legs that *Munida sarsi* has left for walking or standing are also modified for the texture of the loose mud. They are fine and pointed, covered with bristles, and as perfect for walking on mud as they are impractical for walking on rock.

My captive *Munida sarsi* not only ate the mud but dug in it as well. Each scooped a shallow depression for itself and sat in it with only its long front claws draped out over the edge. There it sat for long hours each day, half hidden from sight except for its redness in the shallow water.

If this was all that *Munida sarsi* did, I doubt that it would have held my attention for very long. How-





A starfish begins to burrow in the sand, a technique it often uses for hunting bivalves. Left: although some species of cephalopods have attained the largest size of any invertebrates, those collected in Raunefjord, such as this specimen of *Rossia glaucopis*, rarely exceeded a few inches.

ever, the quiet cleaning, picking, and scraping were only partially characteristic of the animal and contrasted remarkably with its aggressive behavior. Although they were relatively inactive for hours, at other times they roamed, stimulated by internal urges, by the roaming of others, or by outside disturbances. As they moved about in the finite space of an aquarium, they could not help but meet repeatedly or wander into each other's depressions. And when they met, they rarely ignored each other. More likely, they would start displaying or even fighting.

Munida sarsi threatened by stretching and raising its long claws out in front, while at the same time raising its whole body a little farther off the mud. It could, and did, vary this display according to how great the threat was or how aggressive it appeared to feel. Sometimes when one roaming individual walked near another sitting quietly in its depression, the latter would raise one or both of its claws in threat, but not bother to exert itself any more than that. On the other hand, when two roaming individuals met, they seemed to stimulate each other to display with increasing intensity, until their claws were as high as they could go and their bodies were so far off the mud that half of their walking legs could no longer reach it.

Most interesting were the extraordinary fights that two such threatening individuals might get into, for fearsome though they looked and acted, the fights invariably were harmless and highly stereotyped. Facing each other and threatening, they would snap only at each other's claws, apparently aiming for the joints. They looked then as if they were fencing rather spastically, following a set of rigid rules.

I wanted to discover just what elements of the display of one actually stimulated another to display in return, and so I spent a while making the kind of toy that immediately identified me as a student of animal behavior. I made models of *Munida sarsi*, painted them the right colors, gave them movable and correctly proportioned appendages, and confronted the real animals with them. I even made some into puppets in the hope of stimulating a few fights as well as displays.

My models, of course, were ignored. They did not fool *Munida sarsi*, although they looked good to me. I know now that the elements I was looking for were not simple ones. As so often happens, however, pure chance provided some insights into the most important features of a display.

I did not catch enough *Munida sarsi* to systematically cut off appendages in order to observe behavioral changes, but a number lost an appendage or two when they were caught in the trawling net. So I had, in addition to my intact animals, some that were missing one or more walking legs, some missing one of the large claws and several missing both large claws. Only these last individuals, lacking both of their weapons of combat, were entirely ignored by all the others, no

matter how much they raised their bodies off the mud and strutted about. Those lacking only one large claw fought, and won, as often as those that had both claws to fight with, and those lacking one or two walking legs seemed unaffected by their loss.

The display and combat of *Munida sarsi* were typical of what we recognize as aggressive encounters. It was stereotyped, involving specific postures, actions, and reactions. The movements were subtle and finely coordinated, and this I expect explains why my models were so unsuccessful. The patterns of color on the appendages, and the contrast of dark and light that a threatening individual displayed, helped to emphasize the movement, just as body posture emphasized the extension of the claws. And although I watched over a hundred fights and countless displays, I never saw an animal harmed. When one was grasped at a possibly painful spot while in combat, it would either cease fighting or spurt energetically away.

Munida sarsi reserved its fencing behavior for conflicts with its own kind; when otherwise disturbed, it reacted with what seemed to be indiscriminate behavior. Some kind of social hierarchy usually accompanies stereotyped conflict, but I could not discover any in this case. Although every fencing match had a winner, I could rarely predict which animal would emerge victorious, even though I could detect differences in body size or claw length and knew the previous records of the combatants. The benthic world is not one of complex social systems, perhaps because elaborate communication is difficult in such an environment. Rather, each animal seems concerned only with defending its own private space, no matter how small that may be. At least, that is the way it appears to be for *Munida sarsi.*

This community of animals, all adapted to living in a deep, cold, dim, featureless, and muddy environment, is not entirely untouched by problems of the twentieth century. Traces of our pollutants probably extend to the deepest parts of the oceanic abyss. Moreover, the hungrier we become over the next decades, the more we will keep of what we now throw back from a full trawling net. Today, the deepwater benthic community is almost untouched. Because it remains so inaccessible, it continues to withhold most of its secrets from us. It is not affected by the little we know about it. The community of red animals has been in existence for a long, long time and should survive our current crises more easily than most.

One of the most powerful and agile of the crustacean swimmers, the red crabs, *Geryon tridens*, intimidated all the other animals under observation.

HEALING IN THE SIERRA MADRE

Prescription: Heat in alcohol one scorpion, one centipede, one black widow spider. Expose overnight to the dew

by David Werner

In a small Mexican village I was shaken awake one night by a young *campesino* whose sister had just been stung by a scorpion. He pleaded with me to come quickly. Armed with an injection of antivenin I hurried to the family's adobe house, but found that the treatment had already begun. The young woman's husband had hunted down the offending scorpion on the dirt floor, chopped off its tail, split the animal open on its ventral side, and bound the still-wriggling creature to his wife's stung finger.

In the barrancas, the steep ravine country of the Sierra Madre of eastern Sinaloa, northeast of Mazatlan, such a treatment is typical. Here, many small farms are a day's journey or more from the closest road, and in the summer rainy season, weeks may pass when communication with the outside world is impossible. Although the Mexican government has taken large steps toward providing rural health centers in isolated sectors, the remote reaches of the Sierra Madre have no such services as yet. The people are forced to rely on their own ingenuity, plus the traditional folk cures handed down from the past.

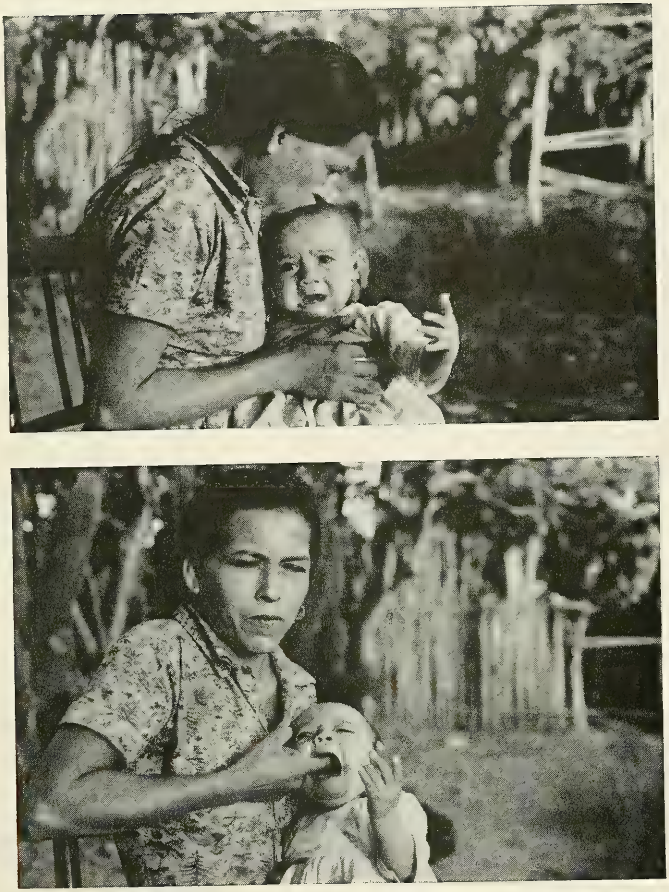
While the modern medical aid I have been providing for the past five years is usually gratefully accepted, the villagers are understandably reluctant to give up the folk cures in which they have placed their faith and hope for centuries. Many come for help only after their attempts with home remedies have failed, and if modern medicine seems too slow or unpromising to them, they may suddenly switch back to traditional remedies. More often, however, folk medicine is applied simultaneously with whatever treatment I recommend.

On the surface there seems to be more madness than method behind the array of herbal cures and folk treatments found in the barrancas. But I have learned from the *curanderas,* as female herbal healers are called, that many cures are guided by time-honored assumptions. For example, the treatment for scorpion sting described above reflects a local saying that "every poisonous animal also has an antipoison."

Such home brew "antivenins" are common. One broad-spectrum remedy, claimed effective against many different bites and stings, is prepared by heating one scorpion, one centipede, and one black widow spider in alcohol. To give it potency, villagers insist that the brew be exposed overnight to the dew. Other remedies are specific for particular poisonous creatures. For rattlesnake bite, for example, some villagers cut open the live snake, remove the gall bladder, and smear the bile on the bite. Others claim it is more effective for the victim simply to catch the snake and quickly

The author holds the venomous beaded lizard, whose cast-off skin is applied to bites of other poisonous animals.

ring treatment for
obbing headache, the
ient's forehead is
ked with a live toad.



Villagers believe infants' fallen brains cause diarrhea, so women "raise" them by sucking fontanel and pressing on palate.

bite a piece out of it, although I have yet to see this done.

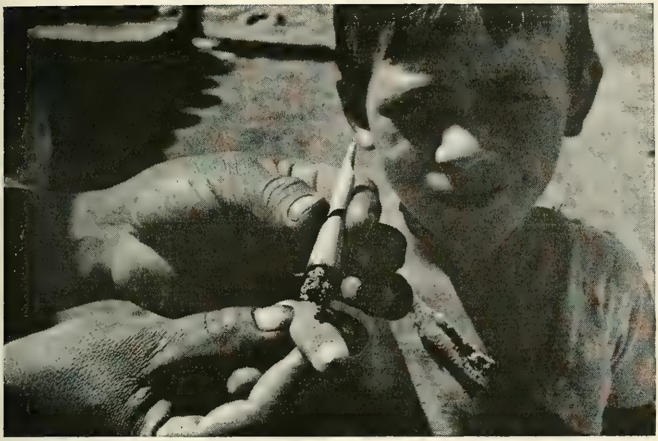
"The more poisonous the animal, the more potent its antipoison," is another folk rule of the barrancas. Since the Mexican beaded lizard—a close relative of the venomous Gila monster—is feared as the most deadly of all animals, it is understandably revered as an antidote against every type of animal toxin. Its shed skin is applied against the poisoned bite or sting to effect a cure.

Although the villagers believe, quite rightly, that the beaded lizard is highly poisonous, they also maintain, erroneously, that this lizard can spit large distances and that its saliva is the cause of *pinto,* a piebald skin condition of the aged. Piebald skin is also reputedly caused by eating pork and drinking milk at the same meal or by getting angry after taking a purgative. This sort of explanation for ailments, especially skin conditions, is common in the barrancas. For example, ringworm of the scalp is said to result from a butterfly landing on one's hair. Ringworm of the body, however, is attributed either to moth's urine or to the bite of a mosquito that has previously sucked a toad's blood.

These odd and unfounded explanations for otherwise inexplicable maladies call to mind the American folk myth that "toads cause warts." In the barrancas, toads are, in fact, considered deadly, but they are not accused of causing warts. Nevertheless, one must be careful never to kill a toad, as this may cause the rains to fail in the summer planting season. As for warts, every *campesino* "knows" they are caused by contact with iguana blood.

In the pharmacology of the barrancas, the application of venomous animals extends far beyond their use as antivenins. The rattlesnake, or *víbora de cascabel,* for example, is a crawling medicine chest. Rare is the village hut that does not have a coil of *víbora* hanging by a leather thong over the cooking fire within handy reach in case of medical emergency. Various anatomical parts of the rattlesnake are used for infirmities ranging from boils to bronchitis. While the treatment of tonsillitis requires a species of rattlesnake found only in the high sierra, for most cures any rattlesnake will do. Most of the prescriptions are very explicit. Consider the treatment for miner's cough (silicosis). "Cut off the head and tail of the rattlesnake, powder the remains, mix with water and drink. For best results, tease the snake before killing it, as this potentiates the 'antimicrobial' action." The rattlesnake has even entered the realm of preventive medicine. When I asked a mother why she hung a necklace of rattlesnake bones around her baby's neck, she replied, "To prevent the diarrhea caused by teething, of course."

The use of venomous animals to treat venomous bites is representative of the homeopathic, or "like cures like," principle, which crops up time and again in the folk medicine of the Sierra Madre. Some aspect of the curative agent usually resembles or strongly suggests the infirmity it is supposed to counter.



A wart, attributed to contact with the blood of an iguana, is treated by searing it with hot cigarette ash.

Such resemblances probably inspired the discovery of the treatment in the first place, although perhaps unconsciously, for the *curanderas*—who gain knowledge of a new cure in a trance or dream—seem totally incognizant of the homeopathic relationship. Nevertheless, it is often quite evident. The rattle of the rattlesnake, for example, is pulverized and placed in the ear for treatment of earache. The fang is used for curing toothache, the tip being inserted into the offending cavity.

Many quasi-homeopathic cures can be cited. To prevent a dog bite from becoming infected, the hair from the tip of the dog's tail is boiled and the wound washed with the water. If, however, the victim wishes to revenge himself against the dog, he plasters a poultice of red chili pepper against the bite. Being hot, the chili pepper is supposed to "bite back" and cause the dog's death.

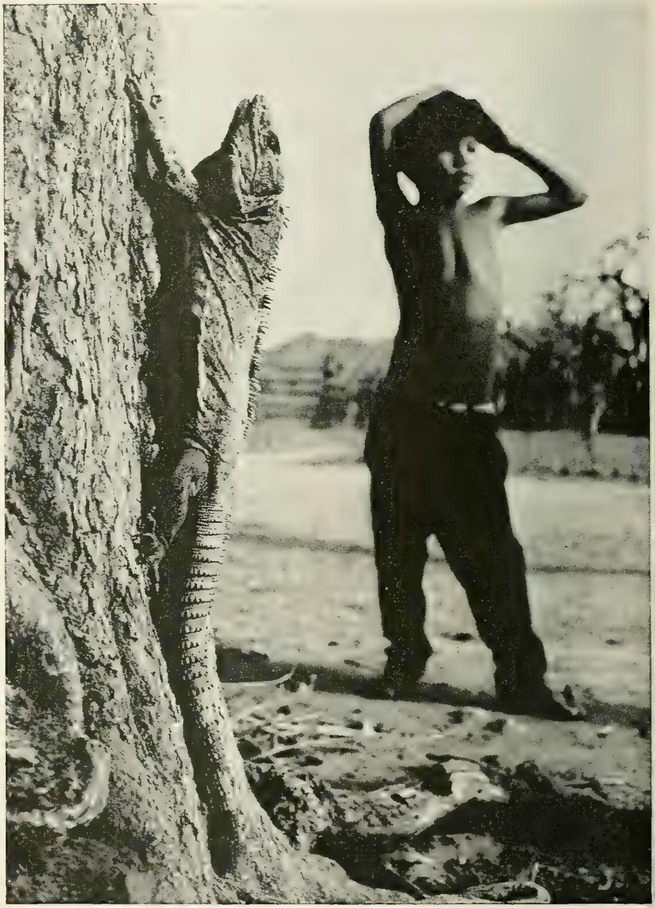
Absurd as it may sound to us, this sort of "remote control" seems probable to the villager whose life is rich with witches, demons, and other supernatural beings. In his world there are many similar examples. The infected fissures that develop on a cow's teats because of poor milking hygiene are attributed to spilling some of the cow's milk over hot coals; therefore the villagers always heat milk with great caution. When a fishbone sticks in someone's throat, he must hurry to the cooking fire and turn a flaming fagot so that the unlit end ignites; this will dislodge the fishbone.

Many of the herbal as well as animal remedies reflect the quasi-homeopathic principle. There are literally hundreds of herbal folk medicines, for another saying goes, "Every plant has a curative function, if one can but discover what it is." Fortunately, many of the plants give away their secret function through some telltale characteristic of their morphology. Thus we find that *yedra,* a crimson red wood fungus once prized as tinder by the Indians, is used in the treatment of nosebleed and hemorrhage. The broad conical spines, or "bumps," on the bark of *pochote* (wild kapok) are ground up and fed to a child with measles in order to make the spots come out, for it is believed that when the spots bud the disease ceases to be dangerous. *Guaco,* a serpentine vine with a strange, dark flower shaped like the head of a reptile, is widely used in the treatment of snakebite and other poisoning.

Consistent with the homeopathic trend of folk medicine, unpleasant maladies often have unpleasant cures. The more revolting the infirmity, the more repulsive the cure tends to be. For goiter, the unsightly protrusions that bulge from the throats of many of the highlanders as a result of iodine deficiency, there exist a variety of such remedies: tear open a freshwater crab (common in the mountain streams) so that its innards exude, then bind it against the goiter; smear the brains of a turkey vulture upon the goiter three times a day; stroke the goiter with the hand of a dead child; or plaster the goiter with *yerba sin raiz,* "herb without roots," a euphemism for human excrement used medicinally.

In the barrancas, scatology has become a medical art. Animal as well as human excrement is used in scores of specific treatments. Recently I was called to the aid of a three-year-old child who had stumbled into a vat of boiling lard and burned 40 percent of his body. By the time I arrived on muleback, the boy was already suffering from severe electrolyte imbalance and had begun to convulse. As I entered the dark adobe room where the boy was sheltered, I smelled and then saw a platter of fresh cow manure beside the cot. The boy's distraught mother explained that it should be spread on the child's hand, but unable to remember whether the dung should be smeared on the right hand or the left, she hadn't dared apply it. I talked the mother out of the dung cure and administered a balanced salt solution. The child responded, and fortunately, the burns developed no infections.

Urine, like excrement, is a common constituent of barrancan pharmaceutics. Its application ranges from the use of human urine in the emergency cleansing of wounds to a tonic for bronchitis prepared from horse urine. Some of the treatments have mythological overtones. For example, washing the face with human urine controls acne effectively only when done for nine consecutive days beginning with a full moon.



Although the spiny-tailed iguana is not used for food in the barrancas, its meat is eaten as a cure for depression.

I, myself, once had the dubious fortune to be the recipient of a folk cure using child's urine. I had fallen from a rock wall at night and broken several ribs. An old *curandera* was called at once to my aid. She spread out a sackful of corn from which she selected the most rotten and shriveled grains. These she charred over the cooking fire, then ground them into a powder in a big bowl. She then bade her six-year-old granddaughter urinate in the bowl, and when the child had shyly obliged, she mixed the charred powder and urine into a dark, evil-smelling paste. Plastering this over my ribs, she said, "This will prevent the injury from developing *pasmo* or *cancer*." (Both *pasmo* and *cancer* are terms used to define severe infections. *Cancer*, as a folk term, bears no relation to carcinoma.) The remedy did, indeed, prove successful, insofar as no infection resulted. As for side effects: it itched!

Creatures renowned for their ferocity are also frequently credited with medicinal powers. The meat of the peccary (wild boar) is cooked and eaten as treatment for general debility. Lard of mountain lion is smeared on painful joints to relieve arthritis.

In addition, animals that are in some way odd or atypical may be blamed for otherwise unexplained infirmities, and therefore used in curing them. The praying mantis is accused of causing cattle bloat. The bat is reputed to cause blindness by urinating in the eyes of sleeping persons. Glowworms are thought to be deadly and are blamed when someone who has slept in the fields dies unaccountably.

The list of animal remedies goes on and on, and as I flip through the file I have drawn together, I find, for example, the following annotations under louse: place a human louse in the eye to remove a foreign object. And, throw a pig louse in the ear of a mule to cure it from rearing its head back when the bit is put in its mouth. Under pig, I find: to cure your husband's alcoholism, secretly sneak one thimbleful of pig's milk into his liquor. Under iguana: for depression, eat fried iguana meat, *but not the meat of the green iguana*. Green iguana is thought poisonous and is blamed, along with the devil, for staggers in cattle.

With this kaleidoscope of folk cures, the question arises as to how many, if any, of these remedies have medicinal value. Apart from their psychological benefits, the efficacy of many of the treatments is at best dubious, yet some have definite merit.

As a general rule, I find the greater the number of folk cures enlisted for one malady, the lesser the likelihood that any will be effective. (The same is true, of course, for modern medicine. One need but review recent medical literature on tetanus or snakebite to see how varied and contradictory are the findings and recommendations when dealing with such often fatal, yet enigmatic, maladies.) Few, if any of the antipoisons have merit in the treatment of venomous reptile and arthropod bites. Therefore, one finds an astonishing array of additional remedies: animal, herbal, fecal, mineral, and even musical. Violin music is prescribed for the bite of poisonous spiders! (The latter treatment was perhaps suggested by the violin-shaped marking on the cephalothorax of the deadly brown recluse spider.)

On the other hand, if one single cure exists for a malady, and especially if that cure is widely practiced, there is a fair chance that it may be effective. In the treatment of cuts and other wounds, the astringent juice of the cactus *Pachycereus pecten-aboriginum* is apparently effective in checking bleeding. I have seen this demonstrated many times, and now I even prescribe mouthwashes of the juice of this cactus, with good results, in cases of severe bleeding following tooth extraction.

Chemical analysis has validated the medicinal properties of certain of the local plants of the barrancas. The herbs with proven curative properties, however, are usually not those with telltale characteristics relating them to the maladies they serve. The same is true of animal cures: the more obvious the homeopathic link between malady and remedy, the less likely it is that the cure has any physiological value.

There are, however, some curious folk cures worthy, at least, of further investigation. The small amount of venom that remains on the rattlesnake's fang may, in fact, have an anesthetic function for toothache. Crayfish, eaten whole and alive to increase lactation in women do, no doubt, provide needed calcium. In some cases, the use of cow's urine mixed half-and-half with milk and taken on an empty stomach apparently is effective in the expulsion of intestinal worms. One cure for arthritis, that of letting a bee sting the affected joint seems improbable; yet, before the introduction of corticoids, some European doctors used honeybee venom to treat joint disease.

The use of oil of *vagre*, "catfish," in the late stages of bad burns deserves special study. Gross scarring in severely burned villagers treated with catfish oil is often dramatically less than that of patients with equivalent burns treated in the best American hospitals. This is of special interest in light of similar results described in studies of Eskimos, who also use fish oils to treat burns.

The villagers may even be on to some unique biological medicines. For infections in postpartum women, they brew a tea from underground fungus gardens of leaf-cutting ants. Like penicillin, this fungus may combat bacterial infection. Conversely, fresh cow dung, plastered on a child's scalp to control fungal infection, sometimes seems to work, perhaps due to the action of fungus-suppressing bacteria so abundant in fecal material.

If some of the folk remedies of the barrancas have probable merit, others are regrettably harmful. With few possible exceptions, the use of feces, for example, is of no benefit, and when applied to open sores or wounds may be the source of tetanus or other disastrous infections. No less detrimental to health is the so-called *dieta*, or regimen, prescribed for a wide variety of ailments. Most illnesses are classified according to their cause as either *caliente*, "hot," or *fresco*, "cold," and foods used in treatment are classified in the same way. This classification is arbitrary, and bears no relation to either the temperature or spiciness of the food. For some illnesses hot foods are to be avoided, for others, cold foods. If a person has a bad cold, for instance, he should under no circumstances eat an orange, as oranges are *muy fresco* and may produce *congestión*. (*Congestión*, for which there exists a formidable gamut of causes and remedies, is a catch-all infirmity covering everything from appendicitis to heart failure and tetanus.)

One of the most far-reaching and devastating *dietas* is that which a postpartum mother must follow. She must not bathe for fifteen days following childbirth. She must not eat eggs for twenty days. For forty days she must not eat any fruits or vegetables, including beans, the villagers' main source of protein. During these forty days, the new mother may eat young roosters, but not hens—and not roosters that have begun to mate. She must avoid going barefoot or handling moist earth. For twenty days she must avoid eating venison because it is "very cold." In short, about all the postpartum mother ends up eating is corn and, if available, white rice. As most of the women in the barrancas are anemic even before pregnancy, the nutritional deficiencies that result from the *dieta* lower even more their resistance to hemorrhage and infection. If the mother succumbs, the distraught villagers search her past for some violation of the *dieta*, and only when an answer has been guessed at and irrevocably confirmed by repeating it many times do they rest easy once again.

One must wonder about the origin of many of these beliefs and folk remedies. How old are they? From where do they stem? The *campesinos* live intrinsically off the land, and the land, with its unique flora and fauna, its torrential rains and droughts, its absolutes and uncertainties, goes far in shaping the lore of its people. The folk medicine of the barrancas is not static, but slowly evolving, like the landscape itself.

Historically, however, there are three conspicuous sources of the local medical lore. Out of the past have come the myths and medicines of the endemic Indian civilization and of the invading Spanish civilization, whose merger produced the present mestizo population. In addition, there are smatterings of modern science. The influences from these three sources have been turned and twisted until they can exist side by side in the minds of the people. It is not uncommon to see a woman with a migraine headache first bind her brow with the leaf of a wild arum lily, as did her Indian predecessors; then consult a *curandera* to have the causative hex lifted, as did her Spanish ancestors in the Dark Ages; and finally go to a modern quack in the next village to have herself injected, because "injections are good."

From the former Indian culture have come not only the basic herbal cures, but also an intriguing moon lore. Older villagers recall that the full-blooded Indians would sleep with their wives only during the waning moon so that their offspring would be strong and live long. Although this custom has gone out of vogue, the villagers today still cut timber for huts and fences only when the moon is waning, insisting that timber cut during the waxing moon rots more quickly. They still believe, also, that the light of an eclipsing moon will cause developing fruit to shrivel before it matures, but that flying a piece of red cloth from the tip of the tree may prevent this "eclipsing" of the fruit. Once, on my return from the upper villages, I found my favorite red shirt flapping from the top of the mango tree outside my dispensary. In like manner, birth deformities are reputedly engendered when the light of the eclipsing moon falls on a pregnant woman. The danger exists when the moonlight strikes one side of a woman only. As a preventive measure, pregnant women (and often nonpregnant ones, just to be sure) go outside during the eclipse and turn around three times.

Through the Spanish side of the ancestry come other ideas and legends. The oldest relic of folklore pathology in the barrancas traces back to the notorious basilisk of the ancient Greeks. This mythological dragon, alleged to have caused instant death to anyone who looked upon it, has shrunken noticeably in the 2,500 years of its evolution. Today in the Sierra Madre, the *basilisco* is said to be a strange little animal, rarely—or more probably, never—encountered, which hatches from the undersized egg of a chicken that has mated with the soil instead of a rooster. It is said that one has only to look at this ugly, lizardlike apparition and he will go as blind as if he had been urinated upon by a bat.

A number of mythological ailments and their treatments stem from traditions of medieval Spain. One. *caida de mollera,* means "fallen fontanel." When infants get severe diarrhea—as they frequently do in villages where the only sanitary facility is the omnivorous pig—tissue dehydration from fluid loss may cause the fontanel, or unclosed portion of the cranium, to sag inwards. The villagers, observing this, have put the cart before the horse by concluding that the child has diarrhea because its brains have slipped downward. Treatment consequently consists of elevating the brains back into place. Each *curandera* has her own procedure. These include holding the baby upside down over a bowl of hot cooking oil and slapping the bottoms of its feet three times to jolt the brains back into position. Or, moistening the baby's crown with hot oil and sucking upward three times on the fontanel to lift the brains into position. Another recommendation is to open the baby's mouth and push upward on the palate with the forefinger to hoist the baby's brains back into position.

It is surprising how many babies not only survive this treatment, but show improvement afterwards. A few, however, die.

Whatever merits and demerits it may have, the medical lore of the barrancas is not wanting in ingenuity or imagination. The one concept utterly lacking in folk medicine, however, is that very concept upon which modern medicine is founded: scientific method. True, the *campesinos'* desire for answers equals that of the modern researcher. When confronted by an infirmity, they also search for both cause and cure, and find them. Often their line of reasoning is both logical and complex. But there is no provision for checking a rational answer against physical events, no allowance for testing a hypothesis. Rather, the hypothesis is transmuted into a conclusion by the process of simple repetition. "Might it have been this?" becomes, "It must have been this," and finally, irrevocably, "It was this!" Thus we find, because someone's great-grandmother, years ago, ate an orange in the evening and that night died of a heart attack, that today no one in the barrancas will touch an orange after sundown.

Similar conclusions from coincidental events have given rise to folk beliefs that "eggs eaten after dark cause *congestión,*" that "the bite of the green iguana poisons calves," and to many other causes and cures for maladies. By the same token, it is no surprise that the *dieta* of postpartum mothers is so limited. The incidence of puerpeural mortality is high, largely due to lack of sterile techniques by midwives, and the resultant infections are invariably blamed on some violation of the *dieta.* If no violation can be found, a new source of the problem is sought. "It must have been the mango she ate," is quickly abbreviated to, "It was the mango," and from that day on the mango is included on the blacklist. And so the list is expanded until the *dieta* itself becomes a contributing factor in maternal mortality.

Yet never is an attempt made to systematically gather evidence that will either support or disprove a proposed cause or remedy. To search for evidence is to admit uncertainty, and in the Sierra Madre, as anywhere, uncertainty is difficult for man to tolerate. It is easier to live in dread of something specific—even if mythological—than to admit that one does not know the direction in which the danger lies.

Fear of the unknown is the greatest fear of all, and in the prescientific world of the barrancas, the unknown looms large indeed. The *campesino* has neither the equipment nor the know-how to decipher even the simpler enigmas of nature. If he did not buffer his reality with a battery of rational, if sometimes ill-founded, explanations, the maze of unforeseen dangers and inexplicable events would soon be overpowering. Thus we find that in the barrancas, the villagers are devoted, not so much to seeking causes and cures that are valid, but to securing clear-cut causes and cures for everything.

A scorpion that has just stu
a woman's finger is split
its ventral side and ti
against the finger as treatme

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The American Lion

Continued from page 49

tent on smaller prey species.

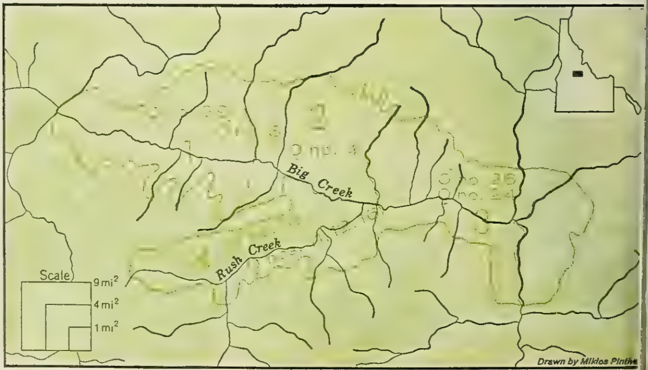
The training of young lions to kill is long and arduous. When the kittens are quite young, the lioness leaves them and hunts alone. Upon making a kill, she returns and takes her family to the prize. She may begin hunting again from this kill before it is entirely consumed, or she may move her family to a different area and start a new hunt. If hunting is difficult, the young may be left alone and unattended for two or more days.

As the kittens grow and are better able to travel, a lioness may take one with her on her forays, leaving the others behind. We recorded this numerous times, but we never observed a female taking an entire litter on a hunt. It is probably difficult for a whole family to approach prey successfully. The young are playful and frolic a great deal—certainly no asset to the hunting mother. More important, I feel, is that the female can better train one kitten at a time in the techniques of hunting and killing deer and elk.

In December, 1967, we tracked female No. 4 and one of her two 18-month-old kittens. They were hunting and had made three unsuccessful stalks on elk. In each instance they had frightened the animal before approaching within striking distance. Finally, the tracks in the snow indicated they had successfully approached an elk calf, and the kitten had launched an attack. While his mother stayed above on the slope, he bounded twice from cover and was upon the elk, but being unskilled he could not complete the kill. The calf had run diagonally across the slope, plunging through the deep snow with the young cat clinging to it. Then the elk's tracks ended abruptly—from above, the female had bounded down the slope and literally killed the calf in its tracks. A skid mark to the willows below revealed its remains, neatly buried under snow, leaves, and sticks. We captured this female and her kitten a short distance away.

The lions hunt as much, if not more, in the day as they do at night. The amount of traveling and hunting depends upon their success. After killing a large animal, such as an elk or a deer, an undisturbed lion usually remains with the carcass until it is completely consumed. We found no instance of wanton killing. And their diet is not limited to big game. They kill and eat a wide range of small mammals: snowshoe hares, wood rats, mice, squirrels, raccoons, and even coyotes. Droppings revealed that

The minimum winter home ranges of three male and six female lions are shown in the Big Creek basin in Idaho. Males may overlap female territories, but maintain a definite boundary with other males.



Drawn by Miklos Pinthe

ground squirrels and pocket gophers were common in their summer diet, along with other, smaller species. Some droppings contained nothing but grasshopper remains. Lions, like most predators, eat what is most easily obtained.

Capturing and observing treed lions at close range told us much about their behavior under stress. Without exception they were calm once they were out of reach of the clamoring hounds. On several occasions, when cornered in bluffs or on a cliff, they lashed out at the pressing dogs but never attacked. And never did they attempt to reach us, although we were within striking distance of treed lions several times.

Two instances are memorable. In one, a male sought refuge on a narrow ledge. As we approached, he disappeared from view. Thinking he had gone around the bluff, Wilbur climbed the ledge to see what route he had taken. Pulling himself up over a rim, Wilbur came face to face with the lion, crouched on the end of the ledge. It had nowhere to go but back toward him. With a mighty effort the lion leaped directly over Wilbur's head and was gone. Another time we released the dogs on fresh tracks of a male and female. While tracking the pair we paused under a small fir where the lions had slept. I glanced up instinctively and there, not more than ten feet above Wilbur, was the male calmly staring down. Apparently he had leaped up the tree as the dogs neared, but they just dashed on in pursuit of the female. These instances and others convinced us that lions attack only as a last resort. They want only to get away.

As we learned more about their habits, we wondered how hunting pairs or families keep track of one another. The key to this question came in March, 1966, when the Division of Wildlife Services of the U.S. Bureau of Sport Fisheries and Wildlife gave me two newborn kittens orphaned in its control operations.

From the time they were very small these kittens made interesting sounds. These could best be described as whistles and resembled bird calls more than anything else. They used different tones when greeting me or each other, when alarmed, or when calling. Other tones (along with a rumbling purr) indicated pleasure and contentment. At no time did I hear them "scream," nor have I ever heard anything like a scream in the wild. They could, and did, make many sounds similar to that of housecats, but much louder.

I am certain that lions in the wild communicate by means of these whistlelike sounds. I had wondered how hunting pairs could separate—one dropping into a canyon, the other circling the basin—then rejoin each other to continue the hunt. Or how a female could call her kittens from a distant ridge.

A piercing, whistlelike sound is used as a warning. Once we met, almost head on in a steep section of trail, a female, No. 7, and her two 20-month-old kittens. The female bounded down the mountainside but the kittens were confused and not particularly alarmed. The female paused and sounded a sharp whistle. Immediately the kittens followed their mother, running pellmell down the slope. The female crossed the creek bottom and paused again. By that time we had released the dogs. She emitted a piercing whistle, and the kittens responded by climbing the nearest tree. The dogs tore on in pursuit of the female, past the tree with the kittens, and treed her a quarter-mile beyond. She had evidently warned her kittens with those sounds.

In addition to studying the dynamics of a lion population, we wanted to establish the ecological role of the mountain lion in a wilderness environment. To assess predation and its effect on populations of prey animals, various factors must be considered. These factors, first advanced by Aldo Leopold, include population densities and the behavioral characteristics of both the predator and prey. Each of these variables considered separately tells us little, but when considered in combination, sound interpretations of the interrelationships can be made.

For four years, throughout winter and spring, we made observations on numbers, sex, and age of big game. Mule deer and elk were the major prey species in winter. A population of 100 to 125 bighorn sheep in the study area made up an

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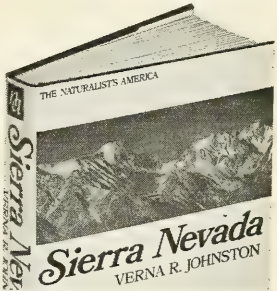

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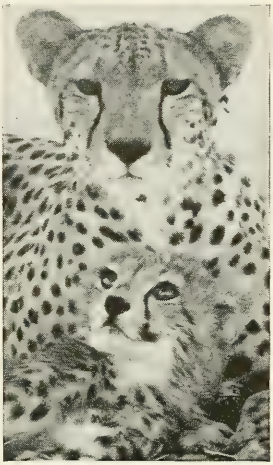

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insignificant part of the lions' diet. Each spring, when big game move to new grass on open, south-facing slopes, aerial surveys were taken.

It is difficult to establish a total population size for big game in such a rugged, mountainous area. However, the data obtained from ground observations, together with those from aerial counts, allowed a reasonably accurate estimate.

The numbers of both deer and elk increased each year. The number of fawn deer per 100 does and calf elk per 100 cows also increased each year. This increase was attributed to three consecutive mild winters. Because snowfall was light, deer and elk were not forced to concentrate at low elevations on the winter range. They ate many food plants that would have been unavailable in a normal winter and came through in good condition. As a result, fawn and calf crops were high, survival was up, and the herds increased. These increases occurred despite the pressure of human hunting each fall and steady predation by lions during the study period.

We found kills by tracking lions to them; in addition, ravens, magpies, and golden eagles often indicated the presence of a carcass. Lions made most kills in rugged bluff areas, on heavily timbered north slopes, along creeks, and in brushy ravine bottoms. We encountered and subsequently captured many lions at kills. At some kills, we were able to identify the predator by characteristic signs.

Deer and elk made up the greatest share of the lions' winter diet. Examination of 198 lion feces showed that these two species comprised 70 percent of the prey. Snowshoe hares occurred 5½ percent of the time, and various small mammals and grass made up the remainder. We also documented kills of three coyotes, two bighorn sheep, and one mountain goat.

We examined 53 elk and 46 mule deer killed by lions in the four-year period and recorded their sex, age, and physical condition. Of the elk, 75 percent were young (1.5 years or less) or old (8.5–9.5 years or more); 62 percent of the deer were young or very old. Lions killed—in proportion to their number in the total population of deer and elk—more adult males and fawns and calves. As shown by the figures in the table below, they killed fewer

Elk and Mule Deer Killed Annually by Mountain Lions in Big Creek Basin During Winter Season, 1964-68

ELK

	Estimated population	% of total population	Killed by lions	% of lion kill
Adult males	121	12	9	17
Adult females	687	68	16	30
Calves	202	20	28	53
Total	1,010	100	53	100

MULE DEER

	Estimated population	% of total population	Killed by lions	% of lion kill
Adult males	220	13	16	35
Adult females	1,101	65	14	30
Fawns	373	22	16	35
Total	1,694	100	46	100

adult does and cows than had been expected.

The data in the table suggest that lions (1) select young and old animals and (2) select adult males. While this may be true, particularly in the case of calf elk, I believe environmental factors, including density of the prey, are more important in determining the kind of animal killed. Lions are opportunists. They will kill an animal that places itself in a vulnerable position. The young and the old do this more often than prime animals. However, buck deer and bull elk often remain alone and at higher elevations than do the does and cows. Further, some bucks and bulls, following the rut, enter the winter in a weakened condition. These factors increase their vulnerability, which, in my opinion, is much more important than numerical availability in determining the makeup of the kill by mountain lions. The lion does not select a particular prey animal; rather, it is selected for him by different environmental factors that increase that particular animal's susceptibility. These factors include prey density, behavior, age, health, interspecific, and perhaps, intraspecific competition, and the lion's predatory characteristics.

To determine the relationship of the elk and deer to their food supply, I appraised the condition of the vegetation on the winter range. Mountain mahogany and bitterbush are probably the major plants in the diet of elk and deer. Despite three consecutive mild winters and the availability of alternate food plants, these two plants were overbrowsed, an indication that too many game animals inhabited the range.

The information gained in our study allows us to make three points and draw the role of mountain lion predation more sharply into focus:

(1) The mountain lion population remained stable throughout the study period.

(2) Populations of elk and mule deer, the principal prey species, increased during the four-year period they were studied.

(3) Elk and mule deer overutilized key winter forage species during the study period.

These data show that lion predation was not limiting the elk and deer populations, but that winter food was the most important factor limiting their numbers. Factors other than food supply controlled the number of lions. By spacing them throughout the area, territoriality limits the size of the lion population within the area. For determining ultimate numbers of elk and deer, lion predation was inconsequential.

Lion predation does, however, dampen severe oscillations in the number of elk and deer. Lions lower the rate of increase of their prey before more drastic forces, such as disease or starvation, take their heavy toll. Lions also keep deer and elk moving on the winter range, thus distributing them more evenly on restricted range and reducing local overuse of the vegetation. In an ecological sense, therefore, the influence on surviving animals is tremendously important. Predation by lions in our study area clearly benefits mule deer and elk populations.

Our work is continuing. Some questions can only be answered by more refined techniques. Graduate student Jack Seidensticker has joined Wilbur Wiles and me in extending our work throughout the year by means of radiotelemetry. By attaching small radio transmitters to the lions, we hope to gain specific information about their year-round activities.

Mankind tends to view wild animals as either "good" or "bad." The large carnivores, such as wolves, lions, and tigers, have always been bad. Literature, movies, and, more recently, television have perpetuated this villainous image. Ironically, although man regards such qualities as intelligence, adaptiveness, strength, and agility as bad in an animal, he admires these qualities in his fellowman and strives for them himself. Fortunately, as we lose some of our pioneer attitudes, the image we hold of many predators is changing. Our society is becoming more appreciative of all wildlife and is demanding a halt to the persecution of many species. The mountain lion, which has long suffered such persecution, now stands to be recognized by an enlightened human society for what he is—a princely animal. ■

"A remarkable construction of the life history of North America's largest and most impressive bird."—Elvis J. Stahr, President, National Audubon Society

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Persuasive Scents in Moth Sex Life *Continued from page 39*

brush type of organ has been lost in many species and, in at least one instance, a completely new organ has developed from the vestiges of it. The implication is that whatever their function, the brush organs are certainly of great adaptive value and as such, are subject to powerful and variable selection pressures; although, as yet, we can only guess at what these pressures might be.

Moth scents have not emerged from our study as universal aphrodisiacs for the would-be seducer; rather, the scents act primarily as either sedatives or attractants, depending on the sex of the producer. For the male moth, enticed by the female lure, they are, in fact, somewhat of a handicap since he is refused his ultimate aim until he produces means of identification or evidence of value as a protector.

The current awareness of pollution problems and the alarm over indiscriminate use of insecticides has created interest in using pheromones for moth control. The economic implications of this are enormous when we consider that among Lepidoptera in which sex attractants are known to be present are the corn earworm, the fall army worm, codling moths, leaf rollers, cabbage loopers, and cutworms, to name but a few. The female attractants are effective in minute amounts and over long distances. They are stable and almost species specific for this purpose. They are also nontoxic to other animals. One possibly effective method would be to use pheromone lures to attract males to particular points where they could then be destroyed without universal insecticide application. This has been attempted with the gypsy moth, *Lymantria dispar*, a severe forest pest, but did not reduce the pest to a low enough density to be termed successful. Pheromone traps are, however, used to indicate when the pest population is building up to plague proportions, and thus, when and where spraying can be carried out.

A slightly different approach suggested by the Canadian entomologist R. H. Wright involves saturating the atmosphere with female attractant to confuse and disorient the males. Hopefully, none will then locate females and mate, although invariably some would mate either through chance encounter or because of the difficulties of insuring an even saturation of the air. The success of any of these methods would depend on the cost of manufacturing and applying the pheromones involved as compared to the cost of insecticides, assuming that the theory would work in practice.

The possibility of eliminating serious agricultural depredations caused by insects is important enough to warrant serious research. With the application of effective and economical pheromone techniques, the abolition of hard pesticides from the world environment could become a reality. The benefits, for both food production and the ecology, would be immense. ■

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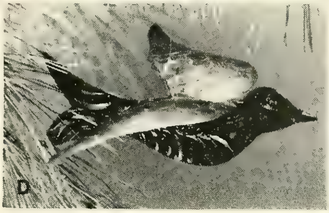
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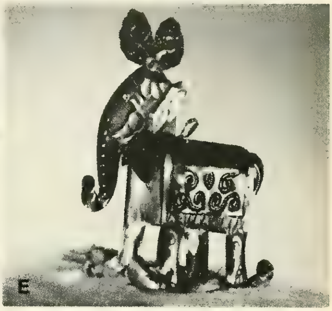
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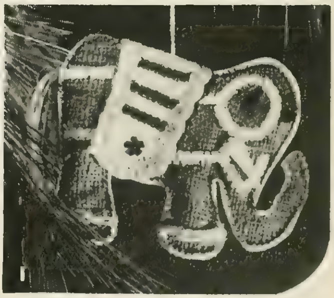
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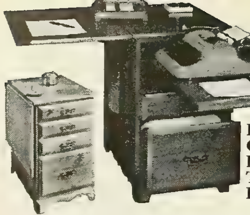

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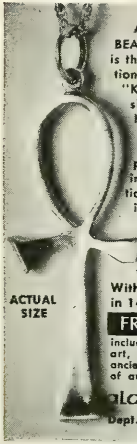

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The Chromatic Wood Sculpture of Mortimer Borne

Continued from page 33

you all the commercial names and all the scientific names. That's actually English maple, over there.

Mrs. B: I can't pronounce it. Anyway, here it is: *A-c-e-r*. And then the next word is *pseudoplat*. . . .

MB: Oh, forget it. I really. . . .

NH: Well, in the process of putting together one of these sculptures, do you take an ax in your hand, or whatever—it's fourteen feet—what do you do, have chunks or pieces and then just cut them up, and then something grows out of that or what?

MB: No, well, I have the wood standing around downstairs. Just standing around. And then I'll make a decision what to start with. A single piece of wood. After starting on it, I have a rough idea in my mind now about the image I'm trying to project and then I cut that piece on the band saw and I proceed—if it's on a panel—to glue it and dowel it on the panel. If it's in the round, I don't do anything until I get the next piece and then I join this piece to the other. But the doweling is most important.

NH: Do you work with any special kind of glues?

MB: No. Basically, I use Elmer's glue or Weldwood. But I don't depend on it. I depend on the dowels. Whenever possible, I have two dowels in a piece.

Mrs. B: Sometimes the temperature will affect the glue.

MB: I was told that certain glues are impervious to this, to that, but I really don't believe it—a change from hot to cold can loosen it up. But with the dowel in, there is no possibility.

NH: What are some of the most exotic woods you have worked with?

MB: Well, let's say, bulletwood, for example. It's very hard—one of the hardest woods—and it was used by the inhabitants of the Virgin Islands way back to build their houses against marauders; in fact, after a hundred years, the parts of those buildings that were made of the bulletwood are still standing; the rest of the house has deteriorated. Actually, a bullet does not penetrate—a bullet in those days, I imagine. Maybe now they have bullets that can penetrate even steel.

Mrs. B: Actually, over a hundred years of exposure to the tropical elements, we still find door frames, windows. . . .

MB: Yes, made of that wood.

NH: What is the scientific name of it?

Mrs. B: M-a-n-i. . . .

MB: Oh, read it, will you please?

Mrs. B: All right. *Manilkara bidentata*.

NH: What are some other woods you've used?

MB: I was just thinking about a very simple wood—birch. I got the shock of my life when I received a piece of birch from Sweden or Norway, I don't remember which. When I sanded it, it seemed to be as tough and as close-grained as steel. One of the most beautiful woods I've ever used. And in a way—the look to it—I have it in one of the sculptures.

NH: You don't interest yourself very much in the leaves or flowers or fruits.

MB: No, no. I think it's difficult enough for me to be acquainted with so many different varieties—with what it looks like. Oh, I learned a lot—I used to think that ebony was such a hard wood; compared to some of the woods that I use, ebony is soft.

NH: Can you work these things with chisels?

MB: I rough them out on a band saw. That I should have told you. I started out by using regular wood cutting blades on the band saw and I used to break at least one a day because it would get hot cutting and spring open. Then I discovered that if I use a metal-cutting blade it's slower but it stands up a long time. So that's what I use—a metal-cutting blade for roughing it out after that, chisels and the gouge same as any carving.

NH: Were you ever interested in going to the tropics to see some of these woods in their natural state?

MB: Yes, of course. I've never had the opportunity so far. Eventually I think I'll do that. I'd especially like to see lignum vitae which I understand grows right in the water. That's an amazing wood. The specific gravity of that wood is almost the same as stone, extremely heavy the heaviest. I believe lignum vitae is the heaviest. An interesting thing about that: they still use lignum vitae for gears in certain inaccessible places—on boats, where it is difficult to oil certain parts. Lignum vitae is self-lubricating and lasts something like three or four times longer than steel. That's an interesting characteristic in wood that few people know about.

NH: Do you have a favorite wood?

MB: Oh, I don't know. The favorite I guess is the one that's most difficult to obtain. American holly. Difficult to obtain because the trees don't grow very large. And it's the whitest wood. When I need a white accent, I use the holly.

Mrs. B: What about the California redwood?

MB: I'm thinking about California orangewood. I was using California orangewood and the sawdust made me quite sick.

NH: You were allergic. . . .

MB: Everybody is—the sawdust, just the fine sawdust will make anybody sick. I read an interesting thing about that. All you have to do is walk into a room in which that California orangewood sits and you'll react. Of course, when it's waxed and dried, it's dead already, you know.

VH: Imagine somebody going into one of your exhibitions, walking in nd . . . .

MB: No, not after it's waxed. It nly affects you immediately after awing it.

Vrs. B: It's really the sawdust that loes it.

MB: I've gone downstairs and I've melled a piece of orangewood and here was that telltale smell, you now.

VH: Do you find chestnut harder o get?

B: Chestnut is not considered a ardwood.

VH: You say you've used it, occaionally.

B: I used it solid. Before I tarted this chromatic wood sculpure. I call this chromatic wood culpture. I named it. I don't know ow aptly.

rs. B: I think it's very apropos ecause, you see, you have what is alled polychrome sculpture. That's sculpture made of one kind of wood and then you use paint and gold and silver, and if you are going to want to look up a piece of work that is sculpture made in that way, you would have to look it up in the index under "polychrome sculpture." Since this is so very different, the thought was not to use polychrome sculpture because it would simply get mixed in. It's entirely different. So this is one of the reasons why we named it chromatic, which, of course, means color.

MB: What I really should do is have an exhibition in New York of the chromatic wood sculpture for about twenty people, which I still haven't done yet. Nowadays, this business here about galleries is so precarious. There was a time when quality meant something. You went to a gallery in New York and if they thought you had something there, they'd put on an exhibition for you and you wouldn't even pay for the catalog. Today it's different—anybody can get an exhibition. You just pay for everything.

Mrs. B: Literally anybody.

MB: It's three, four, five thousand dollars—big business. Now I don't go in for that kind of thing, and I was just waiting for a museum. When a museum gives you an exhibition, you don't pay. That's what I was waiting for.

NH: Is there any aspect of the wood sculpture that we haven't touched on?

MB: I think the most important part of it is the fact that you're able to construct an image of various colors and textures that is different from traditional sculpture. In traditional sculpture, you depend on one wood, one color. You hope to get little differences of grain in the direction of cutting, but that's where it ends. I thought that one could build up sculpture with various textures and various colors, as the spirit dictates. That gives a lot of freedom to the sculpture. You're not bound to that one material and still it could have the unity of material because it's all wood. The polychrome sculpture—much of it is very interesting, but it moves away from sculpture altogether. It becomes a colored image, and in fact,

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the material in which the polychrome sculpture was made is so completely hidden that you don't know of its existence. It could be plaster or anything else, not wood any more. Although wood was used originally. From the fourteenth to the sixteenth century, both in the north countries of Europe and in Spain and even in South America there was much of this polychrome sculpture. It was put mainly in the churches and it was used as a decorative material. It was not intended as an expressive material and all the gold and the semiprecious stones that they used were meant to harmonize with the interiors, wherever it was placed. It is surprising that all through these centuries, somebody did not use wood for what it was meant to be used.

NH: How was wood meant to be used?

MB: It was meant to be used as a color, as a texture, as a material in building sculpture.

NH: Is that the prime reason for trees?

MB: Oh, I see what you mean. Well, I guess, from the point of view of an artist, I guess that's the prime purpose. Either to warm yourself at a fireplace or to carve it into an image. But aside from that, it is surprising because I think even the Egyptians must have had access to various woods and yet they took a piece of wood and either carved it or left it alone, but most of the time, 99 out of 100 times, they painted it. Oh, and there's another thing I want to mention—you people I guess know. From the fourteenth to the sixteenth century, the business of clothing that piece of sculpture was done by a craftsman, not by the same artist who did the sculpture. They were specialists and they would take, for example, a carved figure of a saint and hand it over to this specialist, this craftsman, who put linen on top of the whole thing and then he put clay on top of the linen, and then he would paint it and then he would put gold and silver on top of that. It was completely out of the hands of the sculptor. Now I reacted against all of these things. One of the reasons I started to do chromatic wood sculpture was because I didn't think polychrome was the right way to handle wood. And since every material—wood or steel or metal—has its own quality, my idea was to use the maximum of the material.

Mrs. B: Don't you prefer to build up rather than to cut down?

MB: Yes, that's another thing. That is another thing. It has always bothered me—this business of reducing a stone or marble or wood to your image. It seemed to me that the way a man thinks is more a constructive process: you add your thoughts. one to the other, and someday I hope to be able to do a very fine piece of sculpture by using thi building-up process, because tha would follow my way of thinking i the very process of making th thing and it would reflect the progression of thoughts which is th highest aim, I think, that art has.

NH: Are you going to do muc more wood sculpture?

MB: Yes, as soon as I sell some because my house is getting filled u now.

Mrs. B: He's working.

NH: Are you going to let us publish the prices. We can run some i the magazine and put the price o them or would you rather not d that?

MB: I don't think it would be good idea.

Mrs. B: Actually, prices in the fiel of art do change a great deal.

MB: Wouldn't the magazine objec to it anyway?

Mrs. B: Some of the sculpture ha been appraised for $25,000.

MB: That's not the idea—you sta with a low fee if you want to giv an approximation of prices: it goe from so much to so much, yo know. I would say it goes fro $500 to $25,000.

NH: That letter in *Science* magazine, what was that all about?

MB: This was a thing that was going on about whether science an art can be combined and my lett dealt with the fact that the Alban museum put on an exhibition photographs taken with an electro microscope intermingled with original abstract paintings and the comment there was that the peop couldn't tell the difference betwee the photographs and the painting My point was that it's unfortunat that the whole idea was wrong. photograph is never a work of a in that sense. The electron microscope can discover for us things and objects which we never normally see. It could be the beginning of an inspiration to do an abstract painting, but in itself it isn't, and it should not be confused. I mean, that was the general idea there. There are others who claim that it's all right.

NH: On what basis do they say that?

MB: I think they claim simply, what difference does it make what the intention of the artist is when the superficial effect is the same. My point was that it was only a superficial judgment and that any deeper judgment would discover a difference. Not only that, but I think that anything that is mechanical is not the human artistic process. I'll put it this way: No matter how good a thing is, if it does not display the progression of reactions that an artist has to his work, which goes on all the time while he's making it, then it is not alive. The difference between man's work and the very best photograph or other mechanical production is just that; man's work shows the progress of his thoughts as he's carving or painting or drawing, while in the mechanical part, it's just Bam! there it is and it's finished. Therefore, it is not alive. From my point of view, it is not alive because it does not show the process of living, changing, during the process of the work. If someday, they will be able to do a photograph which will show the various sensitivities of the photographer to the subject, I imagine that I would have no objection. But until such time, I draw the line between's man's work and the mechanical. But actually, I may be influenced by things I saw through the microscope. It doesn't mean that I take the simple photomicrograph, put a frame around it and say, "Here it is," no more than I would take a tree, put it in a frame and say I made a tree.

NH: That would be presumptuous.

MB: It would.

Mrs. B: In other words, an artist may be inspired by scientific subjects, the same thing as one may be inspired by looking at a landscape, but an artist is not a camera.

MB: I would say that a photomicrograph is part of our environment today. The same way that the photograph was, until now, a part of our environment.

Mrs. B: Optical illusions are the same thing. They can be some aspect, something that goes into art but is not art.

MB: I didn't realize that this was going past the point.

NH: Have you ever tried making anything useful, like a canoe.

MB: In chromatic wood sculpture? No, not quite.

Mrs. B: Something useful is that bookcase there. He made that one.

MB: Sure, decorating the bookcase.

Mrs. B: And he built this room out there—that was just another porch.

MB: Well, that's simply decorating useful objects. I think that utility and expressive art are also at variance with each other.

NH: Some of your work reminds me of certain primitive. . . .

MB: You mean the South Sea Islanders. Yes.

NH: Have you ever been stimulated by that kind of sculpture or even something like that of the Northwest Coast Indians?

MB: I have seen, oh yes, when I used to visit your museum I was enamored with the Northwest—I forgot the name of the tribe—oh yes, the Haida. I like their designs. I also read books on Egyptian art and African art, you know. All of these probably influenced me but I don't think any one in particular. I didn't try to imitate the American Indian or the African. I don't belong in the frame of mind. Ours is a different frame of mind.

NH: Tell me something—a lot of young sculptors today are working in metal and glass. Do you have some feeling about wood that keeps you there as opposed to some of these newer materials?

MB: In a way, I would say yes. Wood is an organic material and we react more to organic materials because we are organisms, living organisms. Wood is closer to life than the stone or the metal.

NH: Is that true of people living in New York City?

MB: Even so, even so. Because they live with other people and they have children and so forth and they have communion with their own species. There's a warmth. I think

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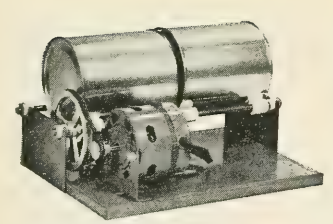

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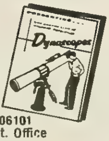

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most people would say that wood has a warm feeling as opposed to metal which is a colder feeling. But as far as what you mentioned—exploiting all the different materials that are coming up—that's all very well except that if I cannot do it in a simple material and I cannot do it any better in a fancy new material, it's ridiculous to go to the new material. In other words, I wouldn't try to take plastics and imitate wood. The simpler the material, the more pliable it is to the eyes. The more difficult it is, the less pliable. One of the reasons why I never went in for metal sculpture is because of the rigidity of the material and the difficulty of bending it to my will.

NH: And at the same time you say that you are delighted with the hardness of wood so that you're also dealing with a rigidity.

MB: A relative rigidity. Relative. I can still bend it to my will; in fact, I bend it to my will much more since I started doing chromatic wood sculpture. I can blend various strains of wood, shape them any way I like. Almost anyway I like.

NH: Let's get back to the organic nature of wood. I don't think you finished that. There was something more intimate about that. The warmth. . . .

MB: Yes. A tree is a living organism, at least the way we understand it. Maybe what we call inert matter is also living in some way, but not in the way we understand it. The tree breathes, the tree takes in certain chemicals, lets out other chemicals, produces leaves, reproduces, and all that. I think that ever since I could remember, I reacted to wood differently than to other materials around me. It's more intimate. I was going to say—you see that little piece there, that breast in the middle figure? That's the one piece that I'm very proud of. It's from my apple tree.

NH: You cut the tree down?

MB: Yes, there was one tree that spoiled; it became hollow in the center all the way up, and the agent from the forestry department told me that it was gone. So I cut it up and found some parts whole. I made two sculptures out of it and then I had a few pieces left, the rest of it was burned up. That's what became of my apple tree. ■

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Ardrey in Wonderland

by Ronald Singer

THE SOCIAL CONTRACT, by Robert Ardrey. *Atheneum Publishers, $10.00; 247 pp., illus.*

Ardrey writes again! With verbal pistols flaming, he straddles his hobbyhorse of territorial aggression and charges up and down evolutionary trails, shooting off behavioral anecdotes in all directions. Like Don Quixote, he lunges at every aspect of daily life, seeking out and expounding on evolutionary causes for student unrest, race riots, postural attitudes at cocktail parties, war, language, family life, men's clubs and pubs, slum ghetto overcrowding—anything, in fact, that will grip the reader's imagination and attention. He seeks out the animal in our past, present, and future behavior, continually squeezing the sponge of animal experiments, observations, and stories—some over and over again—in order to propound and "prove" his theories and philosophies. He worships at the shrine of Science, he tells of elephants cognizant of death (but forgets the whales), and he exalts in the escapades of lions à la Schaller and of mice and men.

His racy style will delight his admirers as he builds up and constantly reshapes his plan of order in disorder, while stirring and whipping up a sort of masochistic brew of reminders that man is but a partially liberated animal. Melodrama stalks the open savanna, the dense Asian forests, laboratory cages and psychological mazes. Wizardlike, Ardrey pulls trick after trick out of the ethological hat, each more remarkable than the previous one.

His critics will find, possibly expectantly, his bombast, cockiness, and holier-than-thou attitude irritating and distracting. He is on sure ground when he is championing and reciting the work and results of others, often in a most personal way (which must be embarrassing to all those pioneering, ambitious, world's finest scientist friends that he name-drops, and annoying to those whom he waves aside, denounces, or harangues). However, when Ardrey gets involved in matters of race and genetics, he flounders in a sea of inaccuracies and dangerous concepts; some will accuse him of racism and European arrogance. In his attempt to give a thumbnail sketch of genetic history relative to his theme—a popular digest of the theory of natural selection and a philosophical view of evolution—he moves beyond his depth and sinks in a morass of

superficiality. While some of his hypotheses are plausible and stir the imagination, others fall flat on their faces because he does not seem to appreciate fully that natural selection acts, not on specific genes or traits, but on whole genotypes and phenotypes. He clutches at rare possibilities, trying to convince the reader that maybe they are facts of potential major significance. Although he concedes that natural selection **means** differential reproduction of genes and gene combinations, his theories reflect a different conceptual basis.

Although justifiable, his attack on behavioral psychologists and sociologists for nonbiological thinking leaves his own flank (biological depth) exposed to the adage, "Judge not, that ye be not judged." He dramatizes, eulogizes, and expands on the importance of variability in human evolution—the central feature of his concept of disorder—but he falters on the handle of population genetics. Again there rears the despised head of the concept of "racial purity." For example, he speaks of the Zulu and Xosa (and others) as "hybrid peoples with languages and physical characteristics distinct from the pure parent race."

It would be interesting if he revealed the secret of this, or any, "pure parent race." And what authority is the source of the gobbledygook that "until about the time of Christ, the black race—what we regard as a human subspecies—was confined to West Africa, excepting only a branch that seems to have spread along the Sahara rim to the Upper Nile"? To say the least, the author has a somewhat skewed, jaundiced view about African genesis in terms of its living populations.

The Social Contract develops the theme of a balance of order (protecting the members of society "whatever their diverse endowments") and disorder (providing "every individual with full opportunity to develop his genetic endowment, whatever that may be"). The balance varies in rigor according to environmental hazard. The subtitle states that the book is "a personal inquiry into the evolutionary sources of order and disorder." It is a variation on the theme of heredity versus environment, and one detects a thread of Darlington's dynamic view of history in it. There the similarity ends. The book has many interesting and enlightening facets, which fill one with admiration for the author's extensive research. The repetition of the thematic sequence, however, tends to bore and is relieved only by the skill of Ardrey's turn of word and phrase. It helps if the serious reader recognizes that the dramatic tone, the intensity and exaggeration, and the views and philosophy of the playwright are based on inquiries into selected source materials that have been adapted for the audience and the times: the author is not an authority and the theories are not facts.

This does not detract from the recognition that Ardrey is knowledgeable about things behavioral, that he has an incisive mind and a vivid imagination. He often hits the nail on its ugly head when developing the backdrop to antiestablishmentarianism, so-called youth revolt, independence and the lack of parental authority, stimulation and boredom, security and anxiety, and violence. Ardrey uses *violence* in the restricted sense, although occasionally he confuses international violence and domestic social change and places heavy emphasis on the "romance" of violence.

He laces his text with some delightful phrases: for example, "the fertilized egg, this randomly determined recombination of parental possibilities, is the accident of the night." and "the pursuit of equality, that natural impossibility, condemns to mediocrity the gifted." Again, writing of Rousseau, "his yearning for those solitary woodland walks where the dream suffers least contradiction." Of course, there is also his devotion to the gimmicky catchphrase, clever in conception and, as intended, lingering in the memory, such as some of his chapter headings: "The Alpha Fish" (individual leadership in the rank order of dominance), "Tuskless in Paradise," and "The Risen Ape" (as opposed to the fallen angels in the writings of Rousseau).

Viewed purely from the scientist's standpoint, there is much for which to take Ardrey to task—not for a healthy difference of opinion (although he takes every opportunity to hammer his critics), but for misleading information, obviously unintentional, that may disturb or fool the innocent reader. It is a pity that he is not aware of, or ignores, his limitations: he reaches into too many dark corners and burns his fingers. Supposition and hypothesis are signs of an imaginative and critical mind and should not be discouraged, but nonsense is nonsense.

This volume is dedicated to Jean-Jacques Rousseau, whose revolutionary views had considerable influence on his time and ours. In *The Social Contract* (1762), also based on natural laws, Rousseau revealed "the revolutionary society in which, property abolished, individuals surrender all sovereignty to the 'general will,' thus regaining at least as full as possible the amity and equality of their origins." Ardrey's book postulates and proposes the opposite, especially in his concept of the individual, setting the scene for future human development. Possibly, he hopes that his book may leave his mark and vibrations as forcefully on society as did Rousseau, for none-too-modestly Ardrey writes, "Rousseau's work appeared over a century before Dar-

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win's *Descent of Man*, whereas mine appears just a century afterward." Rousseau's book also appeared shortly before another event of worldwide significance, the Declaration of Independence. It is unfortunate that Ardrey misinterprets (or misuses) Jefferson's words. In developing his thesis on the disorder of diversity, of inequality, he quotes Thomas Jefferson's "all men are created equal" as being presented as a self-evident truth, but as false in its premise and with no room for maneuver: "And so for almost two centuries American thought, with increasing agony and distortion, has been nailed to a cross of revolutionary propaganda, a passing political slogan which its sophisticated author would have been the last to take seriously." It is doubtful if many people believe Jefferson to have meant *biologically equal* in the sense of *identical*, which is what Ardrey implies.

Similarly, Ardrey's irresponsible discussion of matters dealing with racial inequalities is rather inflammatory. Most paragraphs in that section can be seriously challenged for inaccuracy and superficiality. The indignities perpetrated on, and the maltreatment of, black people (not race, as Ardrey insists) are a matter of history and cannot be dismissed by any reports. There is adequate explanation and sociological reason for "the Negro had failed in American schools," but when this statement appears unclothed in a chapter of pseudoscientific discussion on race in which words like "inferior" and "superior" are loosely used without proper qualification, then it can be mistaken for racism. What world does Ardrey dwell in to state, "until the scientist, without threat to his life, is free to explore in all candor racial differences, and to prove or disprove systematic inequalities of intelligence, an observer of the sciences has little to offer"? The view from his hilltop in Rome must be very blurred.

While cherishing and highlighting man's unique characteristics and individuality, Ardrey occasionally lapses into cynicism and despair. The twentieth century is depicted as a rather unproductive, ineffective, obscure period in which men wander about aimlessly: insecure, unable to discern a pattern for living, derelicts of animated time. This apparent lack of historical perspective begs the question of mental mass suicide. Why should we become depressed that we are not yet superhuman, not divine in our determination of a blazing pathway through an unknown future? A healthy understanding of evolution and a vigorous grasp of its pattern

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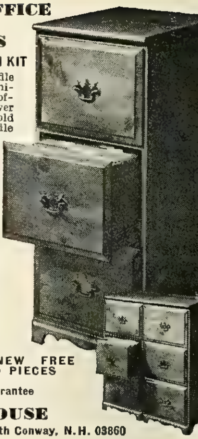

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should make him set aside his Sunday cloak of the lay preacher spelling doom on the street corner, proclaiming evolutionary hellfire and brimstone. In the long view, there is no terror in extinction; more successful forms usually fill the gaps (if there ever were any), and the directional forces, natural selection, move on. Are we to believe that Man sits on top of the evolutionary tree and that no further branching is likely or possible? If the past teaches a lesson, it is that of the optimism of the present. Nietzsche so aptly stated: "Man is a bridge, not a goal."

Ronald Singer is chairman of the Department of Anatomy and professor in the Department of Anthropology at the University of Chicago.

THE PLANT HUNTERS, by Alice M. Coats. *McGraw-Hill Book Co., $10.95; 400 pp., illus.* THE PLANT HUNTERS, by Tyler Whittle. *Chilton Book Co., $8.95; 281 pp., illus.*

Extraordinary, if not downright uncanny. Two books on the same curious but, nonetheless, engrossing subject, both with the same title, appearing nearly simultaneously. Even the subtitles are similar. Nor does the resemblance end at this point. Both authors are British. "Painting and writing occupied [Miss Coats] for a number of years," declaims one of the dust jackets. Mr. Whittle "has devoted himself to writing and painting" since 1947, declares the other. The similarity appears to end there, thank goodness, except that each study, in its individual way, is interesting and well done. The strangeness of the coincidence is compounded in light of Mr. Whittle's observation that "a comprehensive history of botanical exploration has never [before] been attempted."

The two studies approach the subject in strikingly divergent fashion. Miss Coats's book, more detailed and almost twice the length of Mr. Whittle's, begins with the Renaissance. She chooses to break the subject down geographically. Thus, her chapters deal separately with plant hunting in "The Mediterranean and the Near East"—where this activity, like civilized man himself, had its apparent beginnings—"Scandinavia and Russia," "Japan," and so on, the final chapter treating plant hunting in South America, the last great region to be penetrated by horticulturists. Whittle, who discusses the subject from its beginnings in the third millennium B.C., adopts a more conventional approach—treating the exploits and discoveries of one hunter after another in order of his appearance historically. Miss Coats's style is terse and straightforward, but never dull. Mr. Whittle combines a breezy style with an engaging flair for the comic.

In a way it is unfair to evaluate two such similar books in the same review, for there is the nagging temptation to weigh one against the other in nearly every respect, with one or the other always coming off second best. Each, in fact, might succeed admirably in its own way—which appears to be the case in this instance.

While laymen may be inclined to picture plant hunters as benign, retiring creatures generally lacking in the stamina, resourcefulness, and spirit of men who hunt and kill animals, they were, according to Miss Coats, men of courage as well as broad learning. "Besides a good knowledge of botany and gardening, a collector frequently had some skill in ornithology, zoology, geology, surveying or medicine . . . . He had to be adaptable and able to get on with natives, and his life often depended on his being a good shot and fisherman. He had also to have great tenacity and endurance, the conditions of travel being often such that only curiosity, the greatest human motive-power next to love and hunger, could enable him to support them."

The life style and nonbotanical pursuits of earlier plant hunters might have made good copy for the tabloids of bygone ages—just as it has provided good copy for these histories, particularly Whittle's, with his bent for a racy tale. Not the least of such adventurers was Capt. William Dampier (1652–1715), "hydrographer, navigator, author, pirate, and botanical collector" who, according to Whittle, "made life such hell for everyone that his guardian was delighted to turn a blind eye when the boy ran away to sea." It was Dampier who rescued Alexander Selkirk—Defoe's model for Robinson Crusoe—from a desolate isle in the South Seas. When not plundering the high seas, Dampier also gathered specimens for such London luminaries as Samuel Pepys and John Evelyn, who wined and dined him for his botanical favors.

Coats and Whittle terminate their histories with the decade before World War II when, it appears, plant hunting in its most adventurous sense came to an end. "Except in a few remote and backward areas," comments Miss Coats, "plant-collecting as hitherto understood tends to diminish, if not to cease." After read-

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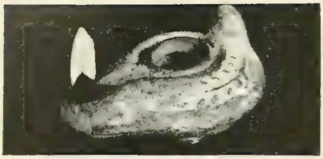

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ing either of these excellent studies, one cannot reflect on her observation without a measure of regret.

He who feels stimulated to revive the "lost art" of plant collecting may turn to the final pages of Whittle's text where he will find all the information he needs about collecting in the field, drying, preserving, mounting, and storing botanical specimens.

DAVID M. WALSTEN
Encyclopaedia Britannica

THE BUFFALO, by Francis Haines. *Thomas Y. Crowell Co. $7.95; 242 pp., illus.*

The subtitle of this book, *The Story of American Bison and Their Hunters from Prehistoric Times to the Present,* aptly describes it. Haines presents the rise and fall of the buffalo in North America, and along with it the rise and fall of Plains Indian culture. The two are interrelated, but the relationship was reinforced by the introduction of the horse into the Plains area, thus providing a more efficient (i.e., deadly) means of hunting this animal. The prime *agent provocateur* in this drama is the white man in North America. In current parlance, this is a historical-ecological study. In it Haines has done a scholarly job.

It is apparent that the spread of the white man in North America disturbed the ecological balance between the buffalo and the Plains Indians to the point where for all practical purposes the buffalo disappeared. The buffalo was the staff of life, providing the staple food for the Plains Indians; it was also the basis for many material products such as clothing, dwellings, containers, and trappings, and the hides were a means of exchange for trade goods. Success and prestige in hunting the buffalo contributed to the focal aspects of the social and political structures of Plains Indian societies. Thus, these societies were dependent for their perpetuation on this species. This way of life is effectively illustrated by black-and-white reprints of Catlin's and Miller's paintings. Haines describes the gradual elimination of the buffalo as primarily due to the demand for hides and meat made by white men. The chapter on "The Great Slaughter" is particularly devastating and should be read by all who are not yet alert to preserving ecological balances in the world today.

The book's closing chapters are a sad commentary on the preservation of a species that, before the coming of the white man, had successfully reproduced and spread extensively throughout much of North America.

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Plains Indian hunting techniques, even before the introduction of the horse and gun, were effective and at times wasteful; but with the coming of the horse and gun, this wastefulness increased. At no time, however, did the hunting techniques of the Plains Indians contribute to the almost complete destruction of the buffalo, for this was an animal well adapted to survival. The virtual destruction of this species was caused by wanton hunters interested primarily in making a "fast buck," and by the hordes of white Americans who trekked across the continent making inroads on the grazing lands and the buffalo, and permanently upsetting the ecological balance.

Ruth S. Freed
New York University

CLIMATE, MAN AND HISTORY, by Robert Claiborne. *W. W. Norton & Co., $8.95; 444 pp.*

Cluttered up by an incredible morass of tangential discussions and polemics, Claiborne's book sets out to present a paleoclimatology from the early Pleistocene to the twentieth century, examining everything from climate and race to why the Vikings were so bold. The author has so many axes to grind, from the psychology of Black nationalism to climate control, that I constantly had to refer back to the table of contents to rediscover the direction of his central argument. In the end Claiborne's prefatory complaint that he had had to read "literally dozens of books, scientific articles, and interviews" rang true in my ear; he just had not read enough to graduate from skeptical dabbling to critical evaluation. The opening sentence of Claiborne's "new philosophy" states that *Climate, Man and History* will outrage many scientists; instead, I found the intellectual potpourri and the game of bait-the-scientist amusing and at times hilarious. But the book is too expensive for one merely to participate in the author's indulgences.

Karl W. Butzer
The University of Chicago

Briefly Noted:

THE MOON AS VIEWED BY LUNAR ORBITER, by L. J. Kosofsky and Farouk El-Baz. *NASA, Government Printing Office, $7.75; 152 pp., illus.*

The portfolio comprises 183 of the most dramatic of the 3,100 pictures of the moon returned from the five Orbiter missions flown in 1966 and 1967. Some are well known to the public, such as the first shot of the earth with the moon in the foreground and the oblique view of Copernicus, which gave many viewers their first inkling of what it might feel like to be there. Most will be new.

The book measures 10½ by 14 and the full-page pictures are a generous 8½ by 11 with extended captions. After a short introduction explaining how and why they were made, the authors move right into the pictures. First, distant views orient the reader; then close-ups examine examples of morphological features. A separate section is devoted to the moon's far side. Stereoscopic views of four features are offered (a viewer is provided). The book ends with technical data on each picture.

J.W.

PERSIA, by James Morris, Roger Wood, and Denis Wright. *Universe Books, $15.00; 216 pp., illus.*

In his introductory essay to this book, James Morris evokes the contrasting sights and sounds of ancient and modern Persia—bell-adorned camels lurching their way to market, majestic archeological sites and monuments, traditionally dressed nomad women with their herds of goats and sheep, modern sophisticated cities with their discothèques. The photographs, however, are the focal point of the book. Roger Wood has captured all the ornate beauty and color of Persia's people and places in a series of beautiful black-and-white and color plates. Denis Wright, a former British ambassador to Persia, has provided the notes to the plates. This is a handsome work produced by three people obviously enamored of their subject.

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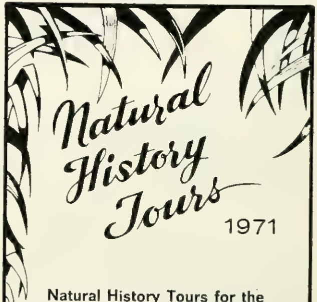

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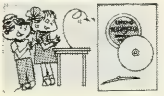

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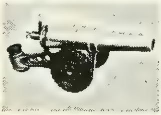

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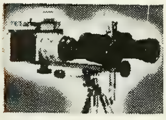

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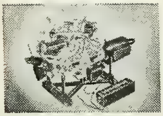

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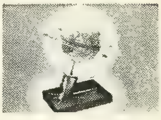

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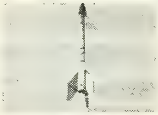

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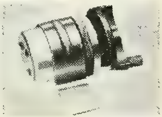

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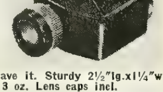

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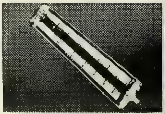

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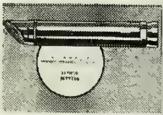

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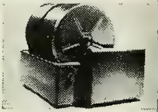

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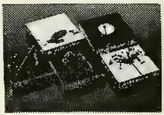

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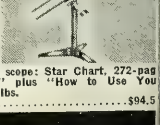

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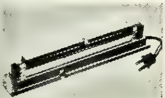

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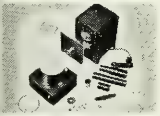

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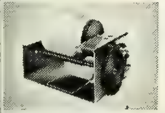

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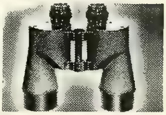

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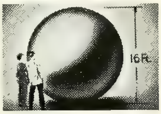

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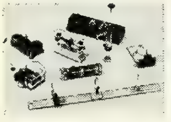

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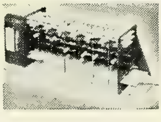

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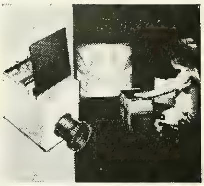

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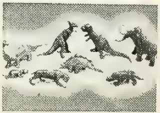

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ANCIENT KINGDOMS OF THE NILE. W. A. Fairservis, Jr. Thomas Y. Crowell Company, New York, 1962.

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PERSUASIVE SCENTS IN MOTH SEX LIFE

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THE SCIENCE OF SMELL. R. H. Wright. Basic Books, Inc., New York, 1964.

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A PRELIMINARY STUDY OF DISTRIBUTION AND NUMBERS OF COUGAR, GRIZZLY AND WOLF IN NORTH AMERICA. V. H. Cahalane. *Bulletin of the New York Zoological Society*, New York, 1964.

NOTES ON COUGAR PRODUCTIVITY AND LIFE HISTORY. W. L. Robinette, J. Gashwiler, and O. Morris. *Journal of Mammalogy*, 42: 204-217, 1961.

BENTHIC LIFE IN THE FJORDS OF NORWAY

THE LOWER ANIMALS. R. Buchsbaum and L. J. Milne. Doubleday & Company, Inc., Garden City, 1960.

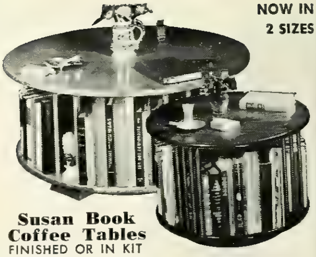
ASPECTS OF MARINE ZOOLOGY, SYMPOSIA No. 19. N. B. Marshall, ed. Zoological Society of London, Academic Press, London, 1967.

HEALING IN THE SIERRA MADRE

CURANDERISMO. A. Kiev. The Free Press. New York, 1968.

THE HEALER OF LOS OLMOS AND OTHER MEXICAN LORE. W. M. Hudson. ed. Southern Methodist University Press, Dallas, 1951.

PUNO MEXICANO. J. F. Dabie. Southern Methodist University Press, Dallas, 1969.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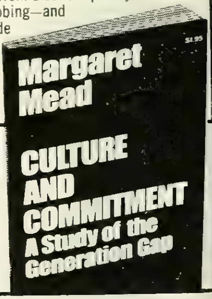

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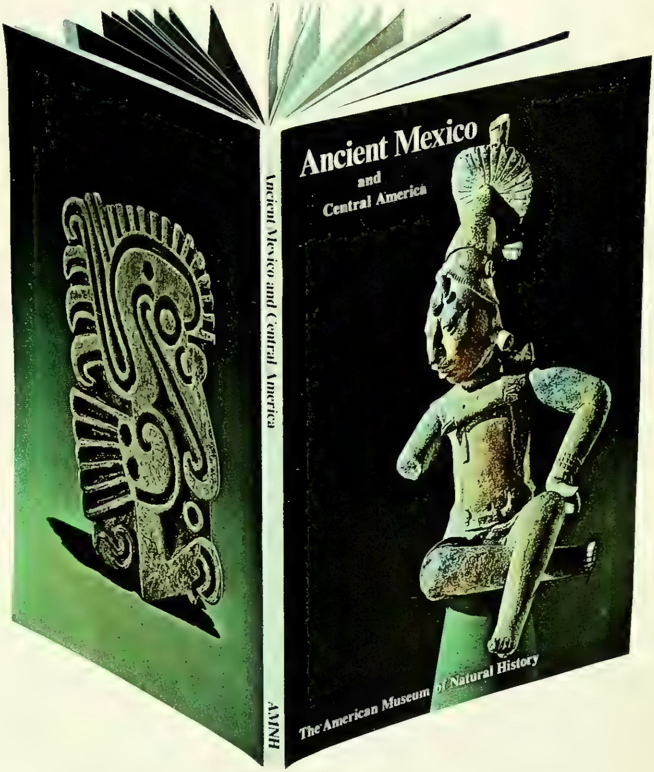
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INCORPORATING NATURE MAGAZINE

The Journal of The American Museum of Natural History

Vol. LXXIX, No. 10 December 1970

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COVER: *As late as the Middle Ages, men thought the universe was sealed, and that if the outer boundaries could somehow be penetrated, the glories of heaven would unfold.*

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Publication Office: The American Museum of Natural History, Central Park West at 79th Street, New York, N.Y. 10024. Published monthly, October through May; bimonthly June to September. Subscription: $7.00 a year. In Canada and all other countries: $8.00 a year. Single copies $1.00. Second-class postage paid at New York, N.Y., and at additional offices. *Copyright © 1970 by The American Museum of Natural History. No part of this periodical may be reproduced without the written consent of* NATURAL HISTORY. *Manuscripts and illustrations submitted to the editorial office will be handled with all possible care, but we cannot assume responsibility for their safety. The opinions expressed by authors are their own and do not necessarily reflect the policy of The American Museum.* NATURAL HISTORY *incorporating* Nature Magazine *is indexed in* Reader's Guide to Periodical Literature.

Fish used to be scared when we looke

Not long ago, the oil industry usually looked for offshore oil with dynamite.

They exploded it underwater and recorded the telltale echoes on a seismograph.

When carefully done, this did little or no harm to aquatic life. But fish were sometimes scared and fled to quieter waters. Fishermen frowned.

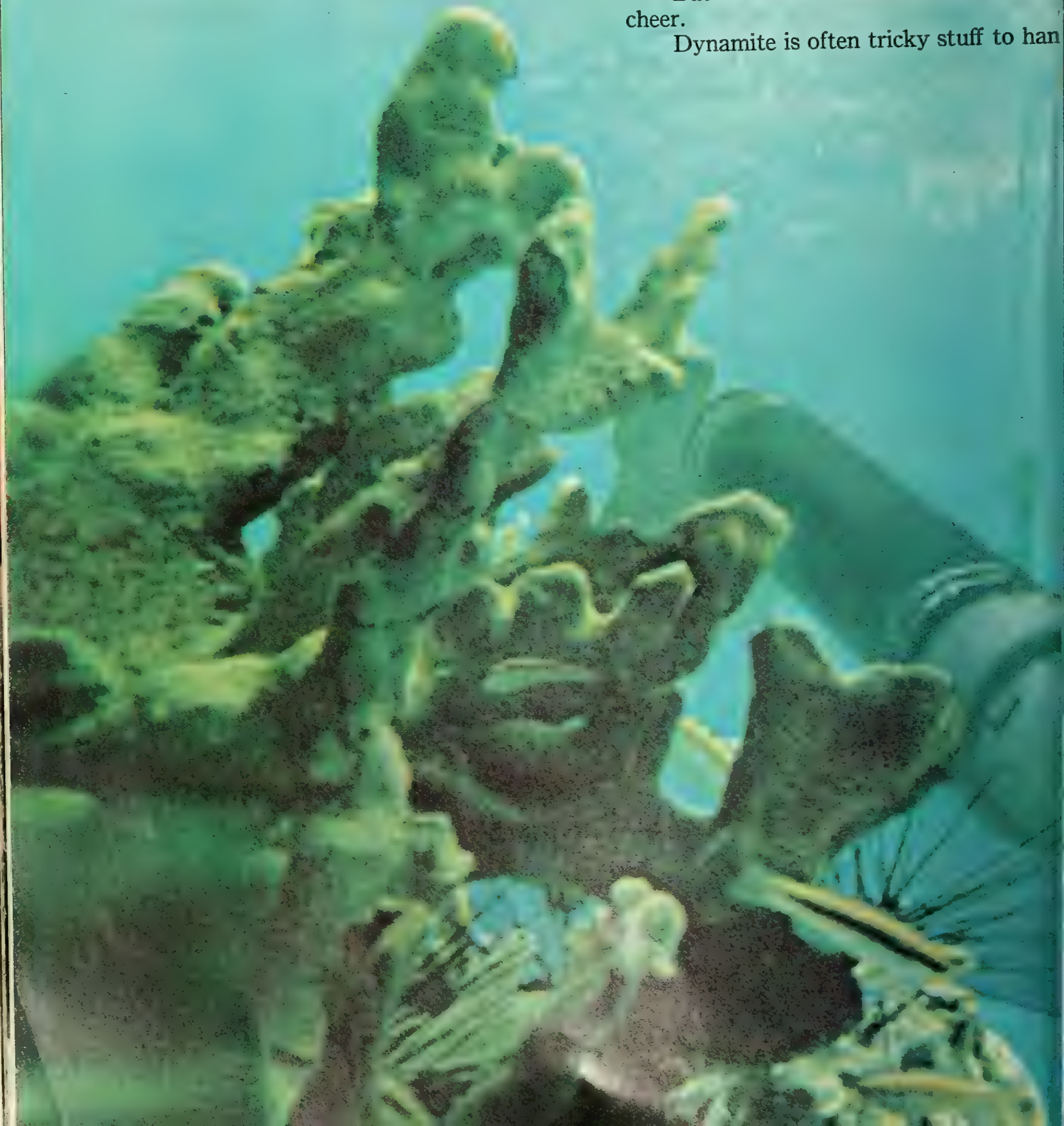
Now, the Esso Production Research Company (a Jersey affiliate) has invented a substitute for dynamite. We have nicknamed it the pop and you can see one in our picture. It does go bang like dynamite. It simply goes pop.

The device is beautifully simple. A m ture of propane and oxygen is ignited b spark plug inside a rubber sleeve. The p inflates the sleeve like an instant balloon.

This sudden expansion is strong enoug give a seismic echo, but not so strong tha hurts the fish.

But fishermen aren't the only people cheer.

Dynamite is often tricky stuff to han



or oil. Now they couldn't care less.

e popper is much safer. Exploration crews e less danger to contend with.

What's more, a crew using a popper can n underwater survey six times faster than ew using dynamite. They can work night day in rough weather. Whereas a dynamite w needs daylight and comparative calm. d our popper gives a better seismic picture he bargain.

Esso Production Research has now made the popper available to the oil industry around the world.

Good news for oilmen. Great news for fish. Quite an invention.

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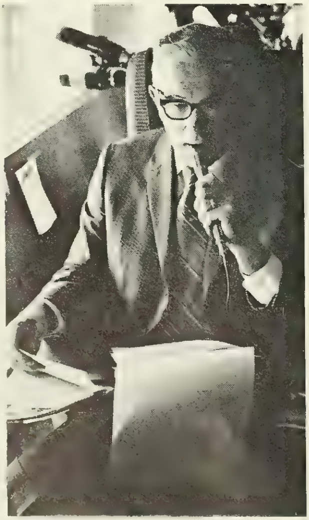
Authors

Luther P. Gerlach and **Virginia Hine**, designers of the questionnaire, "You and the Ecology Movement," which appeared in our June-July issue, presented a preliminary analysis of it in our October issue. This month they offer a final evaluation of their study.

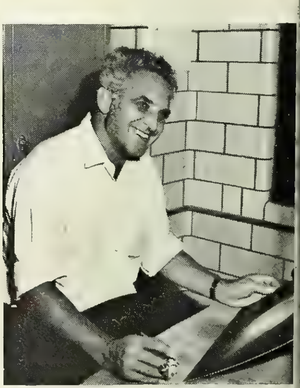
Gerlach is associate professor of anthropology at the University of Minnesota; Hine is his research associate. The background to their work is given in their book *People, Power, Change: Movements of Social Transformation,* published by Bobbs-Merrill last month. Research on the ecology movement and related phenomena was funded by the Hill Family Foundation, the Rockefeller Foundation, the Office of Water Resources Research of the U.S. Department of the Interior, and the University of Minnesota Graduate School.

An independent investigator at the Marine Biological Laboratory at Woods Hole, our "Naturalist at Large" **Susan Schlee** recently returned from a trip to Britain, where she studied the *Challenger* collection from the British scientific expedition led by Sir Charles Wyville Thomson in the 1870's. A graduate of Vassar College in the history of art and architecture, she studied oceanography at Florida Atlantic University and the history of science at Duke University. Mrs. Schlee is currently working on a history of oceanography.

Franklyn M. Branley received his doctorate in science education from Teachers College, Columbia University, in 1957, at which time he was associate astronomer and director of educational services for the American Museum-Hayden Planetarium. Currently chairman of the Planetarium, he has served as consultant and adviser to many schools, organizations, and scientific publications. A member of the American Astronomical Society and fellow of the American Association for the Advancement of Science, Branley has published more than seventy-five books and articles, primarily in the field of astronomy, for children and adults.



Helmut K. Wimmer, whose paintings depicting ancient conceptions of the universe appear in this issue, is art supervisor of the American Museum-Hayden Planetarium. Born in Munich in 1925, Wimmer was apprenticed at the age of fourteen as a sculptor and architectural model-maker. After joining the German army in 1943, he served in the Alpine Troops until 1945, when he was captured by Czech partisans six days after the war ended in Europe and turned over to the Soviets as a prisoner-of-war. During his four years in captivity he worked first in lumber camps in the Ural Mountains and later as a sculptor restoring public buildings in the city of Gorki. In 1949 he returned to Germany where he continued to work as a sculptor on the restoration of war-damaged churches and public buildings. Five years later he emigrated to the United States and joined the art department of the Hayden Planetarium. A master of air-brush painting in astronomy and the physical sciences, his illustrations have appeared in many publications.



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John F. Gibbons II received his B.A. and M.S. degrees from the University of Arkansas and his Ph.D. in geology from Syracuse University. Currently assistant professor of geology at Rutgers University, he has done field work in the Arkansas valley, Colorado Front Range, and the eastern Ozarks. His projected studies include experimental research on the physical properties of rock and a textbook on rock mechanics.

Coauthor with Gibbons of "Rock Music," **Steven Schlossman** is working on his M.S. in geology at the University of Massachusetts. The findings of their study in northern Bucks County, Pennsylvania, were first presented in a paper at the Geological Society of America in 1969. Schlossman is currently studying the Helderberg Mountains in New York State, and plans further research in structural geology.

Associate Curator of North American Archeology at The American Museum, **Richard A. Gould** received his Ph.D. from the University of California at Berkeley in 1965. His archeological field work has been varied: he studied southwestern archeology at Glen Canyon, Utah; Tolowa Indian ethnology and archeology in northwestern California; Mayan cave archeology at Alta Verapaz, Guatemala; and Polynesian archeology at the Tuamotu and Marquesas Islands, French Polynesia. His current article on Pulykara is based on his recent studies of Aborigine ethnology and archeology in the Western Desert of Australia. The author of *Yiwara: Foragers of the Australian Desert* as well as of numerous articles for scientific journals, Gould plans further studies of the Australian desert Aborigines.

Born in Darjeeling, India, in 1922, **Lawrence W. Swan** is professor of biology at San Francisco State College and research associate at the California Academy of Sciences. His article on bar-headed geese is based on research conducted on several visits to the eastern Himalayas, including Nepal and Sikkim. He has previously studied high-altitude ecology on Mount Orizaba and other volcanic mountains in Mexico, and has done field work in East Africa, the Galápagos Islands, and Costa Rica. He is the author of several articles for scientific periodicals and a previous piece for NATURAL HISTORY, "Ecology of the Heights" (April, 1963). Swan's projected studies include pollution fallout on high-altitude snow.

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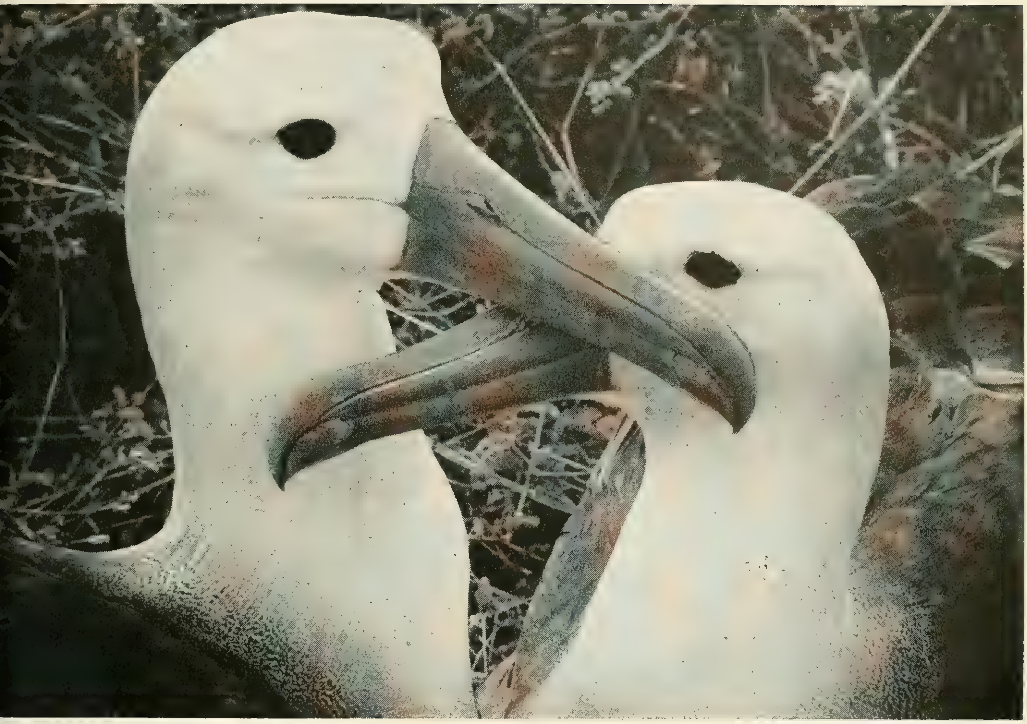

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THE GREAT PYRAMI

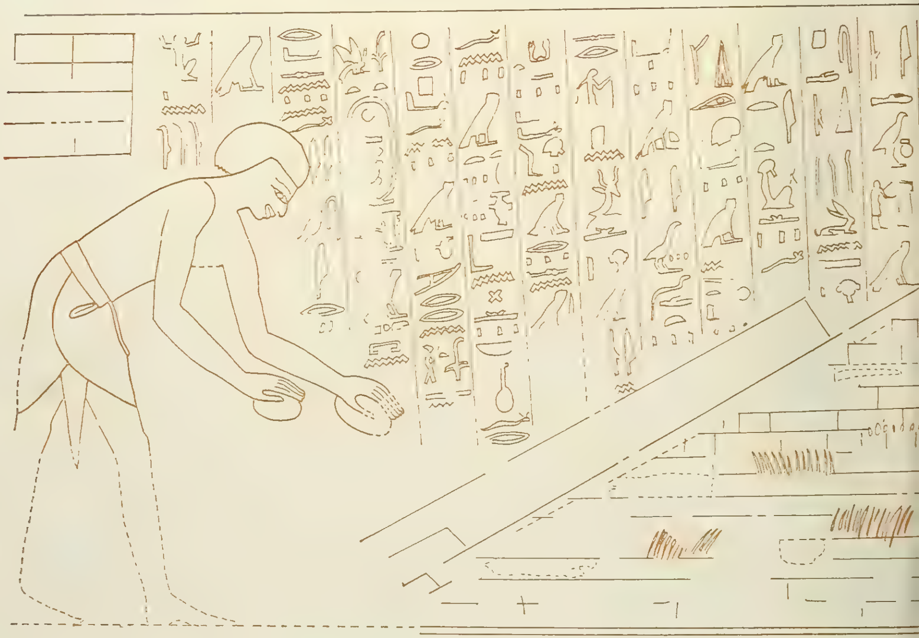
Engineer Olaf Tellefsen argued last month in NATURAL HISTORY that the ancient Egyptians, by using a simple device, built the pyramids with far less work and fewer men than is commonly believed. This month two famous Egyptologists rebut his theory, but Tellefsen refuses to concede

Probably no group of structures is more widely known than the pyramids of Egypt, and certainly none has given rise to more literature. The pyramids have been studied and explained from a thousand points of view. They have been called the granaries of Moses, the evil works of creatures from other planets, the painful reminders of a cruel and deranged king. They have been labeled products of a mentality so great we may never fathom all the secrets their proportions hide. Their dimensions have been measured, added, divided, and squared—in a host of unusual units—to reveal dates in man's past and predict events in his future.

Fantastic ideas? Yes, and with no basis whatsoever. Yet the facts concerning the pyramids are no less amazing than these fictitious notions. Take, for example, the Pyramid of Khufu: so accurately was it constructed that the joints between blocks are never more than 1/50 of an inch wide; the difference between the longest and shortest sides is only 7.9 inches (an error of about 0.0009 percent); its sides are within five arc minutes of perfect alignment with true north. Yet the pyramid was built of 2,300,000 blocks of stone, each weighing an average of 2.5 tons (the heaviest is about 15 tons); it stood 481 feet high; its sides were 755 feet long; its volume over three million cubic yards.

How was it built? How could a people without knowledge of the pulley, without use of the wheel, erect not just this enormous and almost perfectly aligned structure but nearly eighty other (although admittedly less impressive) pyramids as well?

There are many problems to take into account: quarrying and transporting the stones, raising them into position, fitting and dressing them—all these are operations requiring considerable knowledge and skill. Numerous theories have been proposed to explain how these tasks were performed, and one of



Tracing of a painting from 1450 B.C. shows construction ramp in use

DEBATE

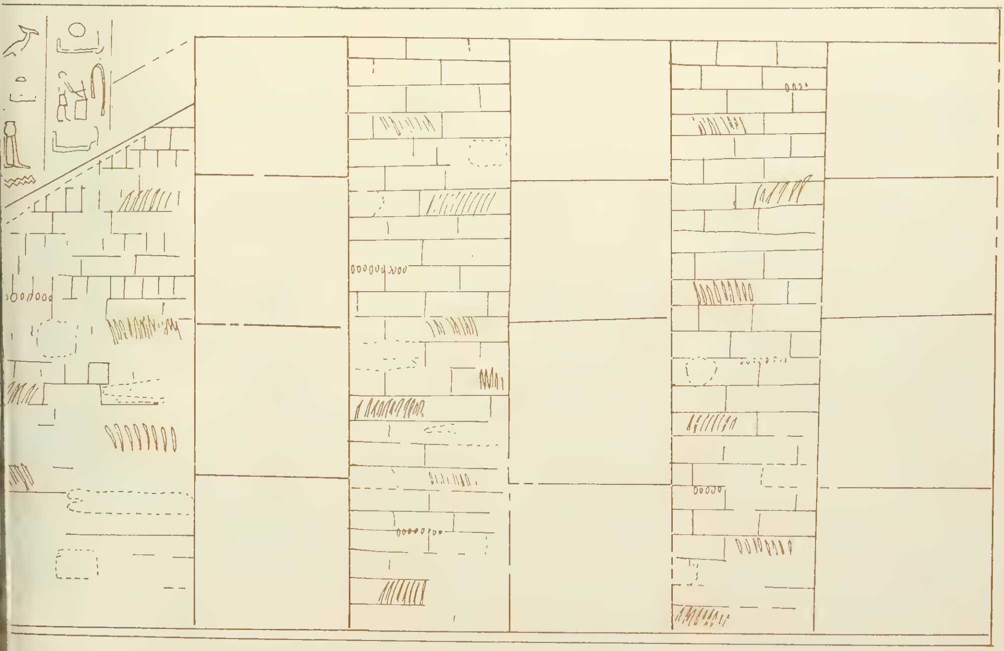
the most discussed is the task of moving and raising the blocks to their position in one of the pyramid's upper courses. The problem: how did the Egyptians manage to raise thousands of two-ton stone blocks several hundred feet without those tools we consider indispensable?

Several devices have been proposed to solve this formidable problem, the best-known and most discussed being the ramp and sledge and any of several kinds of levers.

The use of levers, such as the weight arm described in the article by Olaf Tellefsen, has been proposed several times in the past few decades. Such proposals are usually based on adaptations of the *shadūf*, a device used by Egyptian peasants to raise water from the Nile to their fields. One study of its applicability to pyramid construction was that done by a German engineer, L. Croon, who estimated that 3,500 such levers would have been needed to build the Great Pyramid. In some ways, this and other proposed forms of levers might represent workable solutions to the stone-raising task. But there are several problems.

First, there is absolutely no evidence to show that levers were used in this manner. If they were a part of the contractor's repertoire of tools one would think that, like ramps and sledges, they would have been depicted in tomb paintings found near pyramid sites, or at least mentioned in texts.

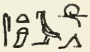
Second, those who seek to justify the use of levers in the construction of pyramids seem to assume that all pyramids are similarly constructed of regularly laid courses of blocks. In fact, only a few pyramids are of solid masonry construction, and none is built of layer upon layer of stone. Instead, for reasons we do not fully understand, they are constructed in what almost appears to be a series of shell-like additions, whose "accretion faces" would make the *shadūf*-like device extremely difficult, if not impossible,



to use. It has been suggested that this building technique would allow the pyramid to be quickly finished off at any of several stages in the event of the king's premature death.

But the dearth of evidence for other devices is only part of the reason that Egyptologists have long favored the ramp and sledge for pyramid construction. Not only are they among the simplest of devices for moving large weights upward, but there is also considerable evidence that they were, in fact, used by Egyptian engineers.

In the XVIII dynasty (*ca.* 1450 B.C.), a tomb painting, *pages 8 and 9,* shows a ramp used for the erection of columns in a temple courtyard. Remains of actual ramps have been found at several sites, including Medum, Giza, and Lisht, where they lie in relation to pyramids. In Papyrus Anastasi I, there is a challenge to a scribe, asking that he determine the number of bricks necessary to construct a ramp (the Egyptian word was



pronounced something like "setja") more than 1,200 feet long, 90 feet wide, and nearly 100 feet high. The description of this ramp fits very well that of the ramp found near the second pyramid at Giza, and its slope is about the same as that of a ramp found near the V dynasty pyramid of Neuserre at Abu Sir.

Every one of these ramps had a slope of approximately 15 degrees. This seems an eminently manageable angle up which to pull blocks. Yet Tellefsen's theory requires us to believe that the stones were pulled up the side of the pyramid itself, an angle of 51 degrees in the Great Pyramid, and rarely less than 42 degrees in others. A task formidable enough; but we also know from several archeological sources that placing the casing stones was one of the last stages in constructing a pyramid and an even slope simply would not have been available up which to haul the core blocks. Thus hauling blocks up the side of the Great Pyramid would have meant hauling them up a staircase. The nature of the evidence, in short, is such that there seems little doubt that the type of ramp to which Tellefsen objects played a major role in pyramid construction and in construction generally.

The evidence for the use of sledges rather than rollers alone is equally as good. Actual sledges have been found at several Egyptian sites, and they are shown in use in a tomb painting, *page 12,* of the XII dynasty, where a statue weighing about 60 tons is being pulled on a sledge by 172 men. Note also in this scene the man pouring water or oil under the skids to reduce friction, and the three men beside the statue carrying a piece of wood (is this another kind of lever, the pry?).

Critics of the ramp and sledge technique argue that too many men would have been needed to haul blocks and that the ramp itself would have been a project rivaling the pyramids in magnitude. How many men were used? We have Old Kingdom records of 3,000 men being used to haul a sarcophagus lid from its quarry to the Nile, and we know that during the annual inundation large numbers of peasants would have been freed from farm work to participate in such a "state project." The statement of Herodotus, that four hundred thousand men labored for twenty years, is certainly an exaggerated picture of the building of Khufu's Pyramid. Petrie estimated that fewer than 100,000 men, working three months each year, could easily have built the Great Pyramid in less than twenty years, and some scholars believe even this figure is unnecessarily high. In any case, we certainly are talking in terms of a labor force Egypt, with an estimated population of 1.5 to 2 million people during the Old Kingdom, could realistically have supplied. As to the size of the ramp, Jean-Philippe Lauer, who has devoted most of his life to the study of Egyptian architecture, argues that most estimates of its dimensions are overblown because people forget that while the first course of a pyramid may contain, say, 64,000 blocks, a middle course would require only 16,000, and one seven-eighths of the way to the top only 1,000. Thus the ramp could be severely reduced in size as it rose and still accommodate the necessary men and stones.

If, as Tellefsen suggests, Egyptologists seem to cling tenaciously to the ramp theory of pyramid construction, it is because only it, of all the theories proposed, is supported by archeological evidence. We do not deny the use of levers—such as a pry perhaps used to load the stones onto a sledge—but careful examination of the ancient records gives us every reason to believe that the ramp was the basic device used in constructing these most awe-inspiring of monuments.

KENT R. WEEKS
Assistant Curator
Department of Egyptian Art
Metropolitan Museum of Art

Tellefsen's article seems to me to disregard the archeological evidence and to offer a theory that is hardly likely to commend itself to Egyptologists. To quote Herodotus, who lived more than 2,000 years after the Great Pyramid was built, is not equal to citing contemporary evidence. The theory simply does not take into account what has survived, including traces of building ramps.

The author should examine the standard work on ancient Egyptian methods of building, namely, *Ancient Egyptian Masonry,* by Somers Clarke and R. Engelbach (Oxford, 1930), and then find reasons to refute the arguments of the authors, which are based on archeological discovery. Incidentally, despite Tellefsen's opening contention, not all engineers and Egyptologists have disagreed: Engelbach was himself an engineer, and he agreed completely with the conventional theory of pyramid building.

Tellefsen ventures some views on the size of the Egyptian population at the time the pyramids were built, but neither he nor any one else has the slightest evidence about the matter; it is pure conjecture. In other areas he reveals how little he knows about Egypt: he talks about digging irrigation canals in the "off-season," when the canals in question would have had to be dug under the water of the inundation! On the question of labor, there is no evidence of "slaves" from foreign countries at the time the pyramids were built.

This article is one of several that have been sent to me over the years, written by engineers and based on

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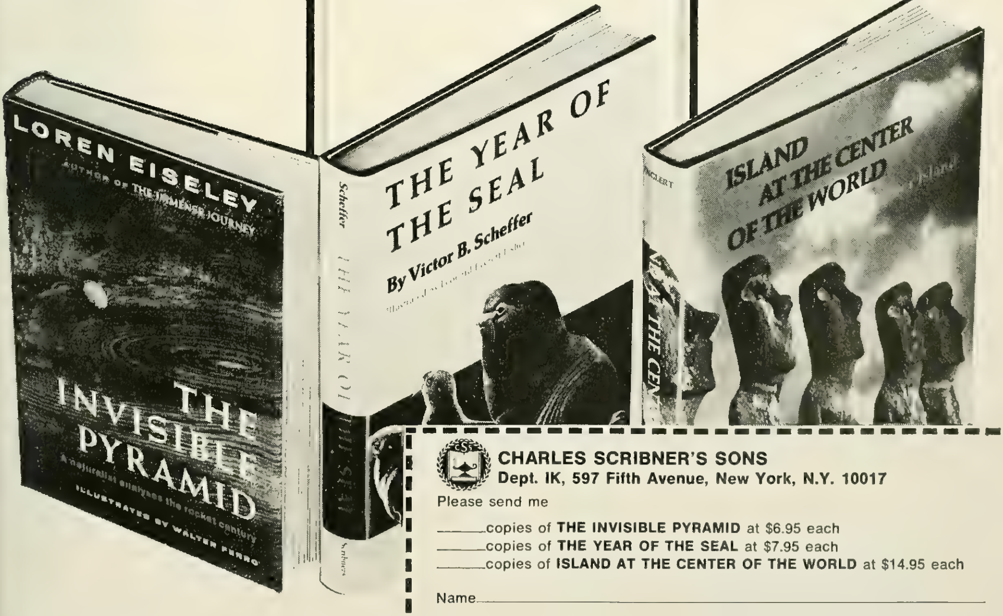
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pure theory. I am sorry that my opinion of it is not more favorable.

I. E. S. Edwards
Keeper of Egyptian Antiquities
The British Museum

The Author Replies

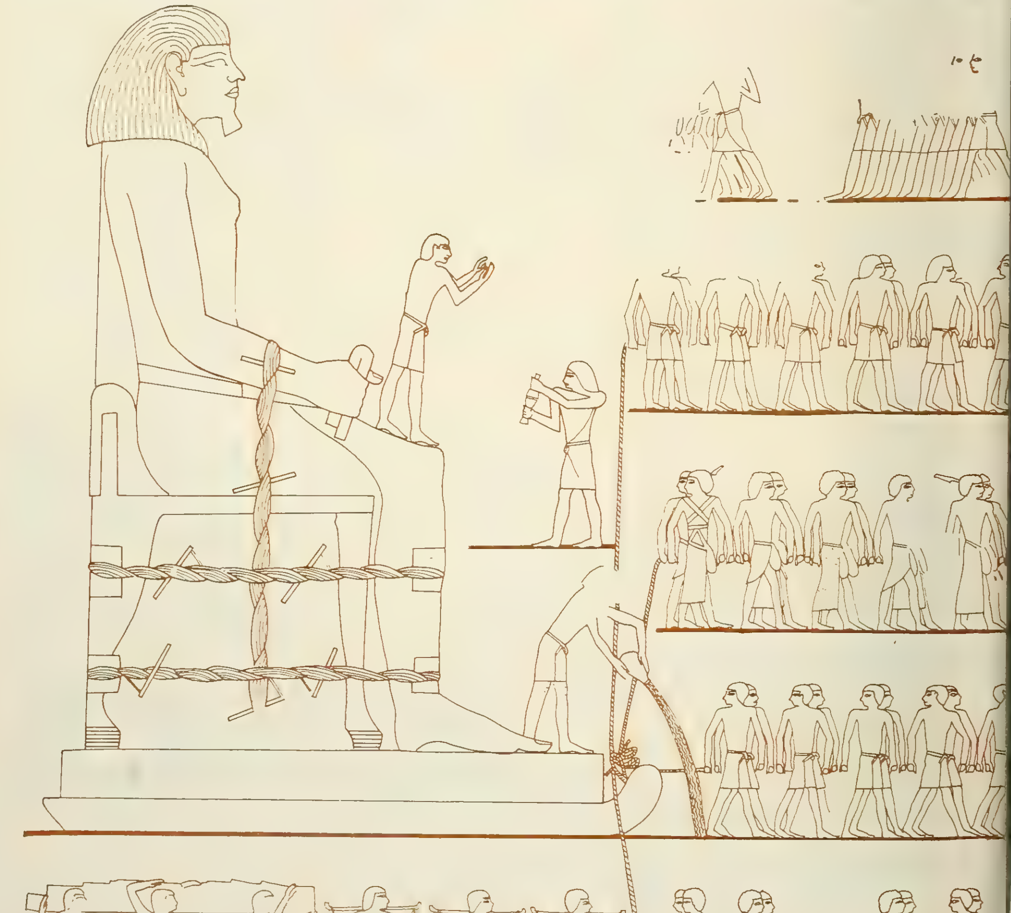
It is gratifying indeed to see the accompanying comments on my article by experts. It is gratifying because the literature on Egypt, and on the Great Pyramid in particular, is so bulky, so diverse and vague that it is difficult to discern what is what, and there has long been a need for a condensation of the essence. Now it appears that Natural History has become a forum for critical debate that may result in the realization of such a goal.

Personally, I am not interested in academic debate for its own sake. My most fervent desire is to see an age-old enigma decided on the basis of technological realities as well as on archeological evidence.

My article speaks for itself and needs no defense or further proof of technical soundness; for what I have proposed can be demonstrated to be feasible, and furthermore, my theory does not involve anything that wasn't well within the capabilities and the material resources of the pyramid builders. Its weakness, according to the experts, is that there is no physical evidence to indicate that the apparatus I have described was used by the ancient engineers.

I believe that there is.

In his comments Dr. Edwards writes as follows: "To quote Herodotus, who lived more than 2,000 years after the Great Pyramid was built, is not equal to citing *contemporary* evidence. The theory simply does not take into account what has



A sledge is used to move 60-ton statue in this tomb-painting tracing.

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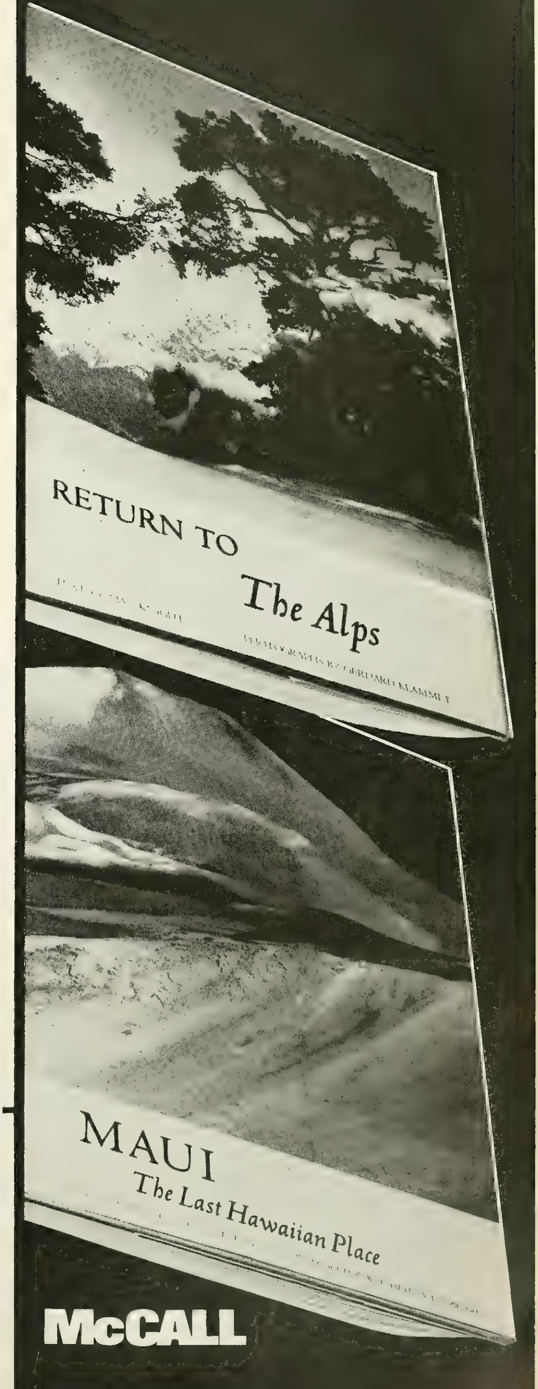

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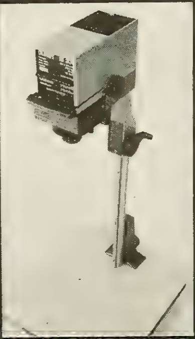

DURST ENLARGERS

survived, including traces of building ramps" [my italics].

That comment, I believe, contains two items whose resolution i essential for the resolution of th over-all pyramid question. The firs of these is the writings of Herodotus. It is true that he lived 2,00 years after the pyramid was built but he got his information from priests who had preserved record of their own—records that wer contemporary in origin with th reign of Khufu. Herodotus did no take his report out of thin ai although it contains some of hi own misconceived observations mistakes that led to summary rejection of the entire report. Som Egyptologists, however, have endeavored to analyze the sources of hi information, and with some significant results. Prof. Margaret Murra of the University of London, for example, has written that the priest had a grievance against Khufu an they vilified him to the best of thei ability. They exaggerated the loa he placed on the people for his selfish purposes, including the buildin of his enormous tomb, which threw the records completely out of tru perspective.

But, to my knowledge at least, n Egyptologist so far has paid an attention to the reasonab assumption that the priests had n bone to pick with the pyramid eng neers. There was no reason fo them to falsify the records with respect to how the structure wa raised. It is my opinion that if huge ramp were the princip means for elevating the blocks, would have been mentioned. wasn't. Instead, they stressed th use of a "machine" made of sho planks. Egyptologists, however, ha to reject this because they had convinced themselves there simp couldn't be any such thing.

I claim that there could, and am prepared to build one and demonstrate its efficiency.

This is the first item to be resolved to the satisfaction of all concerned. It is favored by the fa that it is mentioned in the ancie records, and it is the only exta evidence of *contemporary* origin to how the Great Pyramid was raise

The second item is that there no contemporary evidence of huge ramp being used. All su assumed evidence is taken from post-Great Pyramid structures, and anachronisms can never be contemporary. Dr. Edwards will have to yield on that score. Which same applies to the summary comments by Dr. Weeks, for what has evidence from the XII and XVIII dynasties to do with the Great Pyramid?

Yet, arguments of this nature really settle nothing. There can be no question that Egyptologists know infinitely more about Egypt than any engineer; but neither can there be any question that engineers know more about the application of basic physics and tectonics than the former. And it has become evident that neither discipline by itself can encompass all the factors that go to unravel the puzzle of how the Great Pyramid was raised. But with a sober and sincere dialogue between the two—devoid of all bias—it should be possible at least to eliminate incongruities, leaving only what is technically and circumstantially sound.

The Great Pyramid was the first rue pyramid; it was the largest, he most meticulously planned and ocated, and it bears the hallmark f being a monument to man's chievements up to that time, more han being strictly a tomb. It emodies evidence of every achieved nowledge and skill, so intricately nterwoven in the structure that a ermanent record is preserved in its eatures. Whether by design or by xpediency it is a treasure trove of rcheological gold, mutely challengng and serenely aloof. It is a comlex all by itself, original in conept as well as in execution, and all ater pyramids are merely simulaions but with evidence of new exeriments, particularly in construcion procedures. Hence, such later tructures cannot be used as evilence applying to the original. The reat Pyramid must be treated as nique, as a product of the conummate knowledge of the time. As uch, the question of how it was uilt can be resolved only by defing the level of that knowledge and he manpower economics of the ime—the one being complementary o the other.

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Olaf Tellefsen

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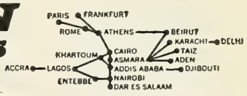

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Many Concerned, Few Committed

More than 7.000 Natural History readers responded to the ecology survey published in the June-July issue this year. Considering the length and format of the questionnaire, this is a remarkable response. It indicates a lively interest both in the problems confronting this nation and in this attempt to discover trends in environmental thinking through the survey method.

Forty-five percent of all the returns came from the northeastern states, 18 percent from the West Coast, mostly California, and 16 percent from the Midwest. The rest were fairly evenly distributed in other areas of the country.

Sixty percent of the sample (5.092 were received in time to be coded and processed) are active in groups concerned with environmental problems. Of these, almost half belong to three or more such organizations. These people are not only ecologically aware, but they tend to be well educated and comfortably situated. Seventy-nine percent are college educated, with 30 percent holding advanced degrees. Forty-six percent have an annual family income of $15.000 or more. Occupationally, the group is weighted (42 percent) in the areas of the professions, education, and social service.

For purposes of analysis, the sample was divided in several different ways: on the basis of age, of sex (57 percent men, 43 percent women), of occupation, and of participation in environmental groups. While the group as a whole may be assumed to differ from the general public in its environmental orientation, there are some interesting differences within the sample itself.

The much-touted generation gap is not apparent, at least on environmental issues within this sample. In general, younger people (the under-30 group), women over 30, and men over 30 in the professions, education, or social service occupations tend to be somewhat similar in diverging from conventional attitudes and the basic assumptions common in our society. Men over 30 in other occupations tend to hold more to conventional views. This sample is, of course, far too small and too representative of conservation-minded people to make any statements about society as a whole. But it might be wise, for those who are interested in social change to stop thinking simply in terms of *older* and *younger* and to explore instead the possibilities of position in the social structure as a key to changing attitudes.

The least controversial issue for this sample of conservation-minded people is population control. Most (79 percent) feel that all families should limit the number of children and a slightly smaller majority (68 percent) would favor encouraging this by removing tax exemptions for more than two children.

Another point on which there is little divergence is the sense of personal responsibility for pollution. Most (62 percent) feel a personal involvement, and 35 percent specifically spelled out the ways in which they are attempting to consume less, recycle wastes, clean up litter, or make even more radical changes in life-style.

Biologists from the University of California at Santa Barbara, in an article for the *Center Magazine* last year, wrote that they felt the job of the ecologist is to dispel "the dominant American philosophy that the answer to most of our problems is technology." They might be encouraged to know that, for this sample at least, faith in technology seems to be wavering. Only 18 percent of the total feel that the environmental crisis can be solved primarily through technological advances. All

A final report on the Natural History survey reveals that when women and the under-30 group rally at the environmental barricades, the generation gap disappears

by Virginia Hine and Luther P. Gerlach

subgroups are similar in trend of thinking, but there are differences in degree. Women over 30 seem to have the least faith in technology (less than the young), and not surprisingly, men over 30 in engineering and technical jobs, the most.

Another issue that has been raised by growing concern for the environment is man's relationship with nature, and his place in the universe. Most NATURAL HISTORY respondents (81 percent) disagree with the statement that plants and animals exist primarily for man's use and enjoyment. It would seem that this is one issue that sets environmentalists apart from the general public. In our preliminary surveys of those groups *not* involved in the conservation-ecology movement, people are about evenly divided on this question. Many people feel that this is essentially a religious issue. In a much-quoted article entitled "The Historical Roots of our Ecological Crisis" (*Science*, March 10, 1967), Lynn White has suggested that "human ecology is deeply conditioned by beliefs about our nature and destiny—that is, by religion." Our science and technology, White believes, have grown out of the Judeo-Christian concept of man as superior to, and dominant over, other forms of life. "By destroying pagan animism, Christianity made it possible to exploit nature in a mood of indifference to the feelings of natural objects."

A question on the survey about whether or not wild animals have any rights is related to White's thesis. Fifty percent of the group felt wild animals have equal rights with man; slightly less than half (45 percent) felt animals' rights were subordinate to man's. The rest were undecided or felt wild animals have no rights. When we broke the sample down into subgroups, some interesting differences appeared.

People under 30 (about one-third of the total sample) are more likely to view wild animals as equal with man, while people over 30 hold to the animal-subordinate view.

	Equal	Subordinate	Unsure or none
All respondents	50%	45%	5%
Under 30	59	35	6
Over 30	45	50	5

When the over-30 group is divided on the basis of sex and occupation, we find that women over 30 are similar to the under-30 group in weighting on the side of equal rights, while men over 30 tend to opt for animals as subordinate. Of the occupational groups among men over 30, businessmen (as distinct from those in the professions, government, or the military, or in engineering and technical jobs) are least likely to grant wild animals equal rights with man.

White's suggestion that Western religions have institutionalized the concept of man's dominance and, by extrapolation, control over his natural environment suggests further lines of research, which we are now exploring. Our preliminary findings indicate that people deeply involved in institutional church activities do, indeed, differ from the NATURAL HISTORY sample on this score. Their responses to these two questions are very much more heavily weighted toward the view of other living species as subordinate to man and existing primarily for his use and enjoyment. Incidentally, this sample indicates NATURAL HISTORY readers as a group are not exactly dedicated churchgoers. Most (67 percent) attend religious services only a few times a year or less, and 30 percent report that they never go.

This conservation-oriented sample is definitely beginning to challenge a number of the fundamental

Continued on page 76

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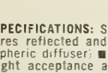
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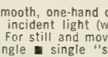
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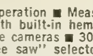
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All the Fat and Sullage Fu

A brief account of several hundred glorious years of inadequate sewage disposal and water pollution

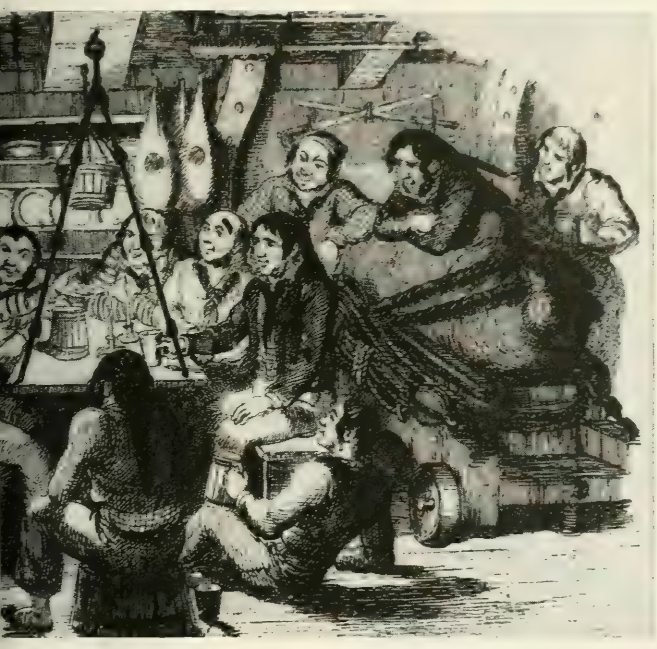
by Susan Schlee

When, in 1851, a thundering storm swept in off the Atlantic and pounded away the sand dunes on the west coast of Mainland Island, in the beautiful Orkneys north of Scotland, it uncovered the simple sewers of Skara Brae. These were not much as sewers go—shallow ditches dug from hut to hut—but because this settlement is considered a remnant of the Stone Age, with a history going back some 3,500 years, its sewers have gained a certain distinction. At the very least they serve to show that the problem of waste disposal is not new. But in Skara Brae the problem was a relatively simple one of segregation: a way was needed to keep the sewage and the food apart. The ditches effected this separation; beyond that, they probably attracted flies, but little notice.

My intention, however, is not to speculate on Stone Age sewage disposal or even to touch, with better documentation, on the ingenious sewer systems evolved by the Chinese, Greeks, Babylonians, and Romans, but to consider instead some of the problems, so akin to our own, that developed in the industrialized and densely populated communities of the late eighteenth and early nineteenth centuries.

In the years just prior to the Industrial Revolution, most of the wastes produced by homes and workshops were allowed to lie where they fell, and if they landed in a river, so much the better. There seemed to be no particular reasons for changing this haphazard system: the river lost its odor and recovered its clarity a few miles downstream, and the cholera and typhoid epidemics that swept through riverside villages were associated with the wrath of God, no the wealth of sewage. In fact, for a few enterprising souls, there was a good living to be made as long as the

urriners



sewer ways remained as they were.

An illustration of that last, and rather curious reason, may be found in a small book published in 1702, entitled *Hints to Brewers* and intended for London brewmasters. "Thames water," it states, "taken up about Greenwich at Low water when it is free of all brackishness of the Sea, and has in it all the Fat and Sullage from this great city of London, makes a very strong drink. It will of itself ferment wonderfully, and after its due purgation and three times stinking, it will be so strong that several Sea Commanders have told me that it has often fuddied their Murriners."

A more common way of utilizing domestic wastes was to strain out the "soot, leaves, matches, straw, candle ends, oily and tarry substances, and other rubbish," then spread the remaining effluent on farm lands. A sewage irrigation system of this sort was started in the 1700's near Edinburgh, and that city's sewage (said to be of exceptionally high class) was spread upon the rich fields that slope toward the southern shore of the Firth of Forth.

These peaceful scenes of sewage disposal ended quite abruptly in the early years of the nineteenth century when industrialization came clattering in, and the production of cloth, paper, iron, leather goods, beer, beet sugar, and potato starch moved out of sheds and dormers into smelly, steam-powered factories. Farmers' sons and daughters left home to work in the mills, and swelled by their numbers, villages grew into towns, towns into cities. It wasn't long before the wastes that had been spread over the countryside began piling up in stinking heaps throughout the new cities. Sewage disposal became a problem.

At first, an easy answer seemed to lie with the rivers. To remain

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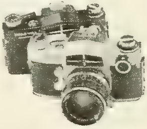

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habitable, cities kept their wastes moving steadily into every stream and freshet within their lines. In England, a Towns Improvement Clauses Act of 1847 required local authorities to discharge their crude sewage into rivers. Obediently, fellmongers, flax retters, slaughterers, dyers, and millers poured their wastes into a common stream and soon "a great diversity of noxious substances" rode upon the waters. Both trade wastes, as industrial sewage was then called, and domestic wastes were dumped into the waterways, which a mile or so downstream, furnished some other town with water for drinking, washing, bathing, fishing, and manufacturing. Because the waterways were also highways, barges loaded with raw materials and finished goods moved cumbrously up and down them. This river traffic, itself, was often a source of further pollution. In Russia, for example, naphtha was transported in leaky wooden barges along the Volga and other rivers, and where these barges streamed their toxic hydrocarbons not a fish or a frog survived.

Gradually it became evident that using rivers as open sewer ways was not an acceptable method of sewage disposal. Most frequently, it was the unimaginable stench, rather than the mounting death rate, that initially suggested a change was in order. To keep the smell at a tolerable level, some cities tried boarding over their narrow streams and canals. As early as 1637, certain sections of London's putrescent Fleet River were covered. In smaller cities and in those located on rivers swifter than the sluggish Thames, conditions did not become intolerable until a much later date—about the mid-nineteenth century—when concern for both the smelly nuisance and the newly suspected danger of water-borne disease began to be expressed.

Official concern for water pollution took the form of either royal orders or parliamentary acts—both equally impractical and difficult to enforce—and was directed primarily toward the safety of people and the protection of fish. One of the earliest of such decrees was an Iris Fisheries Act passed in 1842, whic made it an offense to add to a stream any substance harmful t

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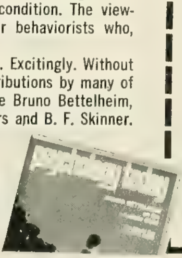

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edible fish. Twenty years later a series of royal orders was issued in Belgium against dumping in rivers; and in Britain, the Royal Commission on Rivers Pollution, later superseded by the Royal Commission on Sewage Disposal, was established to determine how "by new arrangements the refuse from industrial processes can be kept out of the streams or rendered harmless before it reaches them, or utilized or got rid of otherwise than by discharge into running waters."

In addition to governmental concern, a generation of active and enthusiastic naturalists took up the cause of cleaner rivers. The English zoologist Francis T. Buckland wrote *The Pollution of Rivers and Its Effect upon the Fisheries and Supply of Water to Town and Villages*, and in America, zoologist Tarleton Bean bombarded the magazine *Forest and Stream* with "Rubbish in the Thames." "Effects of Garbage on Fish," "Sawdust in Streams," and "Susquehanna River Pollution." In Germany the inevitable *handbuchs* appeared, and in France, scholarly professors wrote *études* on noxious substances, titling them, in their philosophical way, with unanswerable questions.

Whether these efforts, both public and private, helped clean up streams is a moot point; however, the concern they expressed did bring into focus the problem of using rivers as sewers, and by the last quarter of the century it was generally agreed that the harmful elements of sewage should be barred from public waters. But what were these substances, and how could they be detected in, and therefore kept out of, the water supply?

During the first half of the nineteenth century, anyone curious enough to inquire could find out from town and city records that the death rate in riverside communities was curiously affected by a city's position on the waterway. The rate was lowest in towns near the river's source and awesomely high in those at its mouth. No sound explanation for this pattern was offered until the 1860's when the theory was advanced that disease was caused by minute organisms and that some of these could live for a time in water, thereby infecting entire city populations. Bacteriologists, search-

"The troublesome goop was tried as an ingredient of cement...and it was even purified (after a fashion) and mixed with beet pulp to be sold as cattle feed."

ing for these insidious invaders, soon found them. In 1880, the connection between typhoid fever and a bacillus was made, and three years later the German physician Robert Koch isolated the Asiatic cholera bacillus. In subsequent years it was learned that certain amoebas caused dysentery and that some flatworms caused other widespread and debilitating diseases.

The detection of these dangerous organisms was facilitated by new techniques such as staining and culturing, and by the turn of the century, water of suspect purity could be sampled and its impurities could be identified with a fair degree of accuracy. This is, of course, an oversimplification; what actually developed in many instances was the practice of testing water for certain easily cultured or identifiable "indicator organisms" whose existence suggested that other dangerous but less tractable organisms were present as well. Some species of colon bacilli became particular favorites among bacteriologists and were used extensively as indicators of dangerous contamination.

With methods for such detection well in hand, public health workers, who were increasingly given the responsibility of exposing water pollution, went out into the proverbial "field" to test all kinds of water. The field for one employee of the United States Hygienic Laboratory, a division of the Public Health Service, was the railroad station in Washington, D. C., and there, in 1914, he took water samples from a thousand railroad cars. The samples, which he carefully collected in sterilized flasks, were categorized according to the water's origin—Boston, Chicago, New Orleans, Key West, and a hundred points in between—as well as by their source on the train—a big, gurgling water cooler on a sleeping car, a tank riding below a dining car, or a small, refillable cooler on a day coach or a mail car. The results of the analyses were no surprise. The water supply on the trains from the north and west were fairly free of colon bacilli, but on the Seaboard Air Line from Key West, the Southern Railroad from New Orleans, and the Atlantic Coast Line from Florida, Georgia, and the Carolinas, the "storage and handling of drinking

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water [was] wholly inadequate." The water was crawling with bacilli. Train #82 on the Atlantic Coast Line was a particular hazard. Water samples collected from its cars on repeated trips to the Washington station contained colon bacilli in 43 percent of the sleeping car samples, 36 percent of the mail car's, and 72 percent of the day coach's. Another unsurprising result was that no sudden changes were made in the south's railway system as a consequence of the Hygienic Laboratory's *Bulletin #100.*

The detection of dangerous chemicals, which might enter the water with either industrial waste or domestic sewage, was in some ways less complicated than the detection of bacteria, but the effects of these chemicals on humans and fish were very difficult to determine. Even the effects of naphtha or lead tended to be less dramatic than an epidemic of typhoid or cholera and, such being the case, chemical pollutants were less productive of anxiety and consequent correction. Early tests for undesirable chemicals included subjective observations of the color of the water, its taste, odor, and turbidity. Later, more precise determinations were made of the water's salinity, hardness, acidity, and alkalinity and, in the last half of the nineteenth century, additional tests were devised for the detection of metals, acids, and various forms of nitrogen, which, if present, implied domestic contamination. The ability to detect a potentially harmful chemical sometimes outran the ability to predict its effects. Right after World War I, for example, there occurred a catastrophic mortality among oysters from southern Italy to northern Ireland. The popular explanation for the oysters' demise was the practice of dumping surplus TNT and other explosives off the mouths of rivers. There could be little doubt that some oyster beds had received at least small doses of TNT—1,250 tons of it had been dumped into the Thames alone—but no one knew how these chemicals affected oysters, so it was impossible to claim that the dumping constituted a case of harmful pollution.

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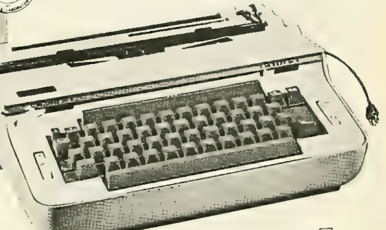

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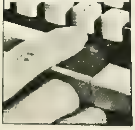

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mystery, added TNT and other explosives to several of their oyster tanks. Other oysters were placed in cages with lumps of TNT and the whole trap was then sunk in an estuary. Explosives, the scientists found, dissolved very slowly at sea and even the shellfish caged with TNT were apparently unaffected. Other sorts of chemical pollution were then accused but each time tests seemed to deny their alleged ill effects, and the cause of the oyster mortality of 1920 and 1921 was never satisfactorily determined.

TNT's acquittal, however, was almost the exception that proved the rule. So many substances were known to kill fish and such a frightening array of germs was recognized as lethal to humans that cities and governments could no longer postpone some attempt at sanitary engineering on the grounds that the evidence for pollution's ill effects was insufficient.

The obvious first step in sewage control was to screen the solids from the effluent before it was poured into a river. In some countries, Germany for example, screening was the total extent of sewage treatment, for it was believed that big, swiftly flowing rivers could handle vast quantities of liquid effluent without permanent damage. But in England, and later in other countries as well, further refinements were required. To remove some of the more finely divided particles, the screened effluent was allowed to stand for several hours in settling tanks; soon it was discovered that if lime and other chemicals were added, many more of the suspended particles would sink to the bottom. This helped clear up the effluent, but it also produced great quantities of muddy residue at the bottom of the tanks, and the problem became one of sludge disposal.

Many schemes were devised for the use and removal of sludge. The troublesome goop was tried as an ingredient of cement, it was used as fertilizer and as a source of ammonia, and it was even purified (after a fashion) and mixed with beet pulp to be sold as cattle feed. A different approach to the problem was to avoid the production of sludge by allowing organic processes to decompose the sewage to such an extent that only a liquid remained. The idea of a septic tank was developed in England and Germany, and at first seemed to offer a complete solution to the sludge problem. A septic tank, as the name implies, allows sewage to putrefy, and the bubbling, gaseous decomposition did indeed break down many solid particles, but not all and not enough. The sludge problem remained despite the many types of septic tanks that began to appear in the 1870's and 1880's. The English named their inventions "biolytic tanks" and "cultivation tanks," while the Germans preferred to name theirs after themselves, the Imhoff tank and the Francke tank, or after the river they were meant to clean up.

The next great leap forward in sewage technology was the invention of the "activated sludge" system. With this method, devised shortly after World War I and currently in use in many English "sewage farms" and in American "sewage plants," sewage is mixed with specially prepared particles (the "sludge" part of the name), which have been overgrown with a thin layer of sewage-devouring bacteria or protozoans (the live, or "activated," part). The murky mixture is agitated and aerated to encourage maximum oxidation and decomposition, and then the whole is allowed to settle. Since not all of the solids are decomposed, the sludge that remains is dried and burned, used as fertilizer, or dumped into rivers.

With big cities and big businesses polluting and with septic tanks and activated sludge systems removing the toxic elements identified by chemists and bacteriologists, we are more or less up to date in the essentials of the water pollution problem. Men have learned what pollution can do and men have learned how to control it—at a price. And there's the rub.

"Little is accomplished except where local conditions here and there become intolerable," wrote the director of the New York Aquarium in 1908. Today the intolerable here's and there's cover a much greater area than they did even sixty years ago, and the uncrowded days of Skara Brae are not even a memory. ■

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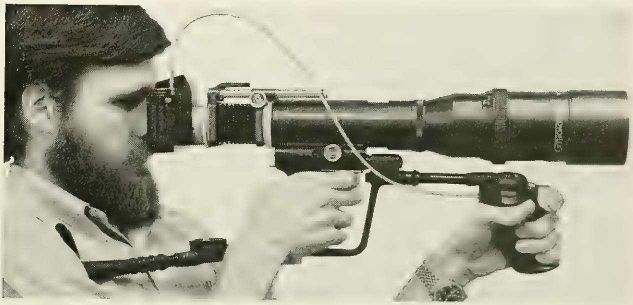

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BROOKS

Conceptions of the Universe

Ancient man devised elaborate explanations for what he observed in the sky—but no more elaborate than those modern man happily accepts

by Franklyn Branley   paintings by Helmut K. Wimmer

In spite of the air pollution of these times, the stars above the eastern Mediterranean deserts continue to shine with the brilliance of millenniums past. But today people see the sky quite differently than did the Chaldeans, Babylonians, Assyrians, and Egyptians of long ago. Many of them slept under the stars. Spreading their couches on rooftops or on the ground, they gazed at the stars, and occasionally a planet, as sleep overtook them. The last sight they saw were the sparkling stars, apparently fastened to a vast inverted hemisphere. Upon awakening, they were greeted by the rising sun. Small wonder that the sun and the moon, the stars and the star wanderers (the planets) held such prominent places in their explanations of the scheme of things.

Failing to find reasons for the motions of the sky, for the coming and going of the sun, the waxing and waning of the moon, and the wanderings of Mercury, Venus, Mars, Jupiter, and Saturn, the ancients attributed them to forces beyond understanding. In many instances, the celestial objects were the gods themselves, some appearing every day; others making periodic visits that called for special observances.

The earth and the sky dominated the lives of men. They were of supreme importance; they were omnipresent, yet they eluded probing and understanding. What were the earth and sky? How were they shaped? How large were they? Where did they begin and end? Such questions have always confounded men. But man of ancient times was not as confounded as we are.

In his ignorance of the composition of space and its geometry, ancient man devised explanations for the things he observed and for their motions. For example, ancient Egyptians considered their world to be a large, rectangular box. The larger dimension of the rectangle was from north to south; the shorter, from east to west. The bottom of the box was the earth, where continents and seas alternated. Egypt was at the center of the narrow, sunken floor, and at the top of the rectangular box was the sky. It seems that some people carried the box analogy to the sky, thinking it too was a flat surface, but others found this idea difficult to accept. They could not deny their senses, which told them the sky was bowl shaped, and so they thought of the sky as the inner surface of a great dome.

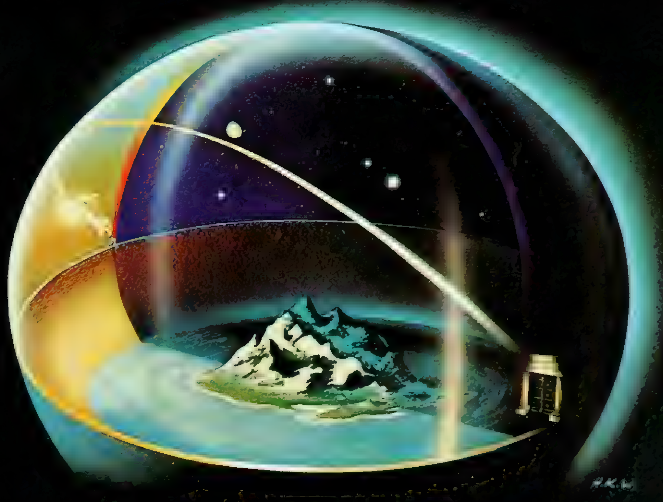
Helmut Wimmer presents us with his versions of both conceptions (*page 31 top, 32-33*). In each, the sky is supported by four high mountain peaks located at north, south, east, and west. The peaks are joined together by rolling hills, creating a wall that surrounds the world. The near surface of the sky, the part toward the earth, is hung with lamps held securely by strong ropes. During the day the lamps are extinguished, probably by a special god, but lit at night, they shine forth and bejewel the sky.

The sun is a disk of fire, the god Ra, which floats in a barge on the celestial river. At sunset the boat passes into the valley of the gods, and can no longer be seen. At sunrise, the craft emerges from the valley, and can again be observed from the earth.

The Chaldeans, a Semitic people who lived in the valley of the Tigris and Euphrates rivers in Asia Minor, were a branch of the Babylonians. They were learned men, often credited with the intellectual and academic achievements of the Babylonians. The Chaldeans were concerned about the rising and setting of the sun, the appearance of the stars, and the size and shape of their world and universe.

To the Chaldeans the universe was a completely enclosed region that floated on top of the great sea (*page 31 bottom*). In their conception, earth was at the center of the enclosure, a great mountain surrounded by a high, impenetrable wall. The sea between the central earth and the surrounding wall was completely forbidden. A person would be lost forever if he ventured upon it. Special permission from the gods was needed to make a crossing; permission rarely, if ever, given.

H.K.W.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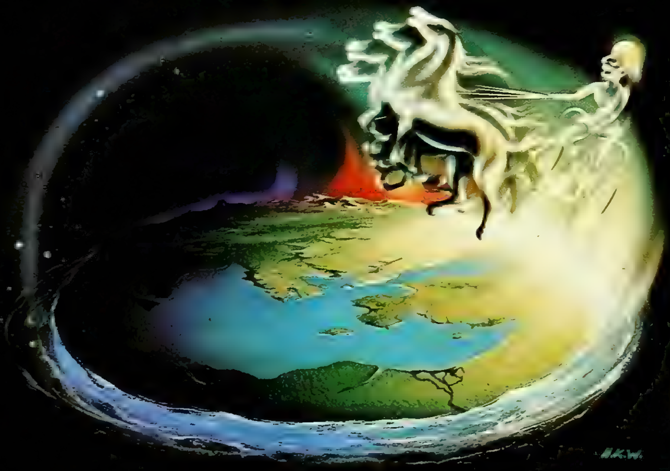
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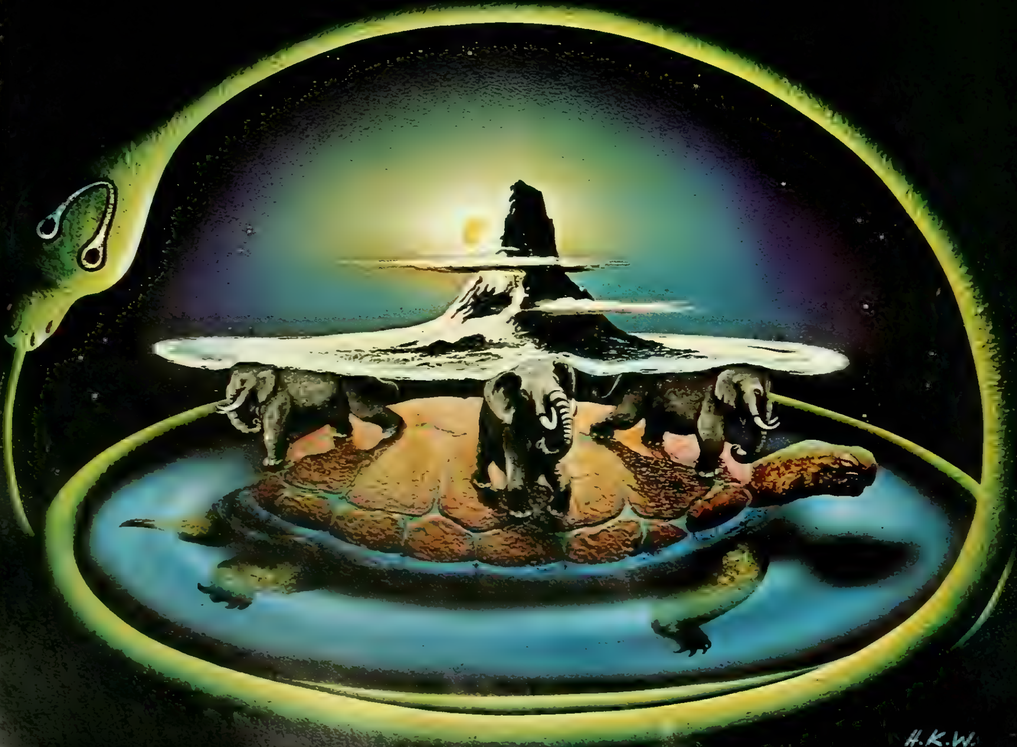
H.K.W.

Heaven was a great vaulted dome that rose above the universe and rested upon the surrounding walls. Heaven was designed and made by Jupiter, one of the important gods of the Chaldeans. He built the dome from a hard metal that reflected the light of the sun during the day. At night the dome was a deep blue backdrop for performances by the gods (the planets), the moon, and the stars.

One half of the universe's great wall was solid. The other half was hollow and had openings at either end. In the morning the eastern gate was opened and Shamesh, the sun god, came through it in a great chariot drawn by two onagers—wild donkeys of Asia. The disk of the sun, which men on earth saw, was one of the chariot's bright, golden wheels. With breakneck speed Shamesh drove across the sky. As evening approached, he slowed down, went through the west gate, and entered the hollow cave of the surrounding wall. Twilight closed the gate. All night the chariot was drawn through and around the wall to emerge in the morning when dawn opened the eastern gate once more.

The people of ancient days often thought of the universe as boxed, or walled, in. This desire to put boundaries and limitations on space has persisted to the present. In this so-called enlightened age, people still find it difficult to comprehend the vastness of space, the great distances involved, the multitude of galaxies. We prefer to think of the universe as our ancestors did—a neat, closed system with specific boundaries and limitations.

As did most early people, the ancient Greeks believed that the earth was flat, an idea strongly supported by the sage Thales of Miletus who lived some 2,500 years ago. Thales taught that water was the basic essence of the earth. He also said the earth was a flat, circular disk (*page 34 top*), whose outer part was bounded by a great, impenetrable river-ocean. Stars appeared out of this boundary sea and set in it each morning.

Helios, the sun god later associated with Apollo, rose out of the eastern ocean in a chariot drawn by four white chargers. As Helios drove the chariot across the sky, the horses breathed light and fire. The appearance of Helios out of the ocean each morning caused the stars to dive pell-mell into the western sea.

Helios was an all-seeing god; his light penetrated everywhere. He was a beneficent god who brought to people the good things of life—light, heat, the growth of crops. No wonder that living sacrifices were made to Helios each year, including the casting of four white horses into the sea.

The Greeks believed that Ethiopians, who lived at the far reaches of the earth, were scorched by the hot sun as it appeared and disappeared below the east and west horizons.

At the outset, the Pythagoreans upset the teachings of Thales, maintaining that the earth was a sphere fixed in the center of the universe, not flat and round, and not floating in a sea of water. The followers of Pythagoras, prominent among whom was Heraclides, ascribed daily rotation to the earth and annual motion around a central fire. Two hundred years later Aristarchus guessed that the earth was a planet moving around the sun. But as we know, Hipparchus, and later Ptolemy, rejected such fantastic ideas. Thus the idea of a sun-centered universe lay dormant for some 1,800 years, waiting upon the work of Copernicus.

The cobra has long been sacred to Hindus, and it remains so in many parts of India. In their concept of the world (*page 34 bottom*), we see once more the desire to enwrap their surroundings, to provide boundaries, thereby giving one security and a feeling of completeness.

To the Hindus the bottom of the universe was a sea of milk bounding all sides. A huge turtle swam in the sea, and became the foundation for the world. Four elephants stood on the turtle's back at each of the four cardinal points: north, east, south, and west. The elephants supported the earth, a symmetrical disk, which sloped upward from all points to a towering central mountain. Atop the mountain was a gigantic fire (a candle according to some versions of the story). All was contained within the coils of a cobra: a neat, compact world.

The need to think of the universe as closed, with definite boundaries, persisted into the Middle Ages, as shown in Mr. Wimmer's cover painting. This concept lost prominence grudgingly only as the Copernican idea received greater attention.

Earth was thought of as a flat plain. Unlike the idea of the early Babylonians and one version of the Egyptian concept, which taught that the sky was a flat plate from which the stars were suspended, this view held that the sky was a hemisphere. It was a solid surface, however, with stars suspended from it by strings. Or, in alternate versions, holes were punched in it, and the bright light of space, or heaven, shone through. The sun and moon were closely related, and they were associated with earth, rather than with the stars (the sky).

The painting illustrates man's desire to physically achieve abstract ideas, in this instance, heaven. Heaven must be something real and concrete. It was logical to believe that it existed somewhere out beyond the sky. All one had to do to see heaven itself was to discover some manner of penetrating the sky. Once this was done, a man need only poke his head through to see the glories that abounded there.

Rock Music

by John Gibbons and Steven Schlossman

On a June day in 1890, Dr. J. J. Ott played several musical selections for the Buckwampum Historical Society in Bucks County, Pennsylvania. He was accompanied by a brass band, but, in the words of one who was there, "the clear, bell-like tones" he was playing "could be heard above the notes of the horns." What made the concert different was that Dr. Ott was making music by hitting boulders with a hammer.

Dr. Ott had put together an octave of ringing rocks from a boulder field in Bridgeton, one of many dotting eastern Pennsylvania and western New Jersey. The peculiar ability of the rocks in some of the fields to ring like a bell had been known long before, but not until 1965 was a serious attempt made to find out why.

Local myths about the boulder fields abound to this day. Little is known about the Indians' opinions, but many early settlers apparently attributed the boulder accumulations to the aborigines themselves. A vague picture of the fields as ceremonial sites built by the Indians runs through many accounts. Nearly all the explanations, in fact, call upon man or some supernatural force for the genesis of the fields; natural origins are rejected altogether. Other explanations invoke witchcraft, arguing that the fields are either the site of a great curse or are areas possessed by witches. The fields have been called the ruins of ancient civilizations, the landing sites of spacecraft from alien planets, and almost anything else that comes to mind. One local maintained that the WPA piled the rocks in a "make-work" effort.

The common thread through most of the region's mythology appears to be a rejection of natural origins for the fields. The failure of science, through some sixty years of intermittent investigation, to provide any better answers must have helped to confirm that idea. Although the fields may have been visited by naturalists long before, the first comprehensive description was not published until 1909.

The ringing rocks fields are not very different from the other boulder fields in the area. Irregular clearings of ten to fifteen acres in the predominantly hardwood forest, the fields are floored by loosely piled boulders varying in size from one to fifteen feet in diameter. The boulders are made up of a dark igneous rock called diabase that is about 180 million years old. There is no soil between the boulders in the field, and they lie on a sloping bedrock surface of the same rock type. Some worts and lichens are the only plants to be found there. The absence of soil to retain rainfall makes the presence of rooted plants impossible. The microclimate of the area has been aptly described as desertlike.

The boulders themselves are usually flat, and their exposed surfaces are often stained reddish by iron oxides. Weathering has sculptured the upper surfaces into a pitted and grooved pattern. The surrounding forest floor contains boulders similar in size and composition to those in the boulder fields. Outside the fields, however, the boulders do not ring, have no reddish stain, and display a peculiar "crazed," or cracked, pattern on their surfaces. One of the persistent observations about the boulders is that they cease to ring if they are removed from the fields.

B. F. Fackenthal published the first scholarly work on the ringing rocks (1909 and 1919). Fackenthal was a naturalist of the breed responsible for much of the early description and exploration of this country. A natural scientist of broad interest and great curiosity,

HOLLINGSWORTH

his description of the ringing rocks fields is an interesting and wonderfully informative work. In the 1919 volume of the Bucks County Historical Society Proceedings, he wrote about the geologic setting of the area, and about the then-current explanations of the phenomenon. Venturing a guess of his own about the ringing phenomenon, he said:

"The ringing properties are doubtless due to the texture of the diabase of which they are composed, but why some should respond with a ring and others lying alongside are non-resonant, does not to my mind fully appear. They were doubtless cooled or annealed differently and therefore the crystalization may have been different."

Little more was written about ringing rocks for the next forty-five years, but boulder fields in general were studied enough to be considered a well-understood phenomenon.

Boulder fields of the kind found in the Bucks County area are not particularly uncommon throughout the temperate and arctic regions of the world. Under climatic conditions that feature severe temperature variation above and below freezing, along with enough rain or snowfall to keep the ground wet, frost action can easily produce such boulder fields, or *felsenmeer* (literally "stone seas"), as they are called in Europe. Water soaking into the bedrock surface expands upon freezing and breaks up that surface. Frost heave, the movements produced in soil by freezing and thawing, tends to move the boulders toward the surface. If the climate is severe enough to prevent plant cover from developing, the soil may eventually be flushed away by summer rains. The result is a boulder-covered bedrock surface with little or no soil.

Huge expanses of boulder-carpeted terrain may be seen today above timberline in most mountainous regions. These *felsenmeer* are more or less permanent features in those regions of high altitude or high latitude having rigorous climates. How, then, can they be related to the temperate, humid climate of the middle Atlantic region? The answer lies in the history of the last Ice Age. Although the glaciers that last retreated from the area about 12,000 years ago never extended to the actual site of the ringing rocks fields, their presence profoundly affected the area's climate. The nearest ice masses are thought to have occurred only about twenty miles northwest of the site. This places the boulder fields well within the range of periglacial, or near glacial, climatic effects. The areas marginal to the glaciers experienced rigorous climates quite analogous to high alpine climates.

G. Gordon Connalley, a glacial geologist, proposes that all of the region's hillslopes were shattered by severe frost action during glaciation. After the glaciers retreated and the climate returned to its present state, the boulder seas were gradually reclaimed by the forests. The fields still in existence are the last remnants of once extensive *felsenmeer*. Even these remnants are being encroached upon by the forest. The trees near the edges of the field are younger than the rest of

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Diabase blocks lie strewn across a Bucks County boulder field, where conditions are perfect for the slow weathering that produces ringing rocks.

the surrounding forest, and in some places the boundaries are blurred by the advance of shrubs and vines into the fields.

In general, none of these ideas about the origin of boulder fields is new. Most geologists have long agreed that most fields originated in the way just outlined. The trick is to explain why the ringing boulders ring.

In 1965 Richard Faas, an oceanographer and geologist from nearby Lafayette College, and John Flocks, a student, took up the problem. Faas and Flocks were interested in problems of sound travel in rocks. This interest arose from Faas's studies of sound travel in ocean bottom sediments.

Faas and Flocks demonstrated that the audible tone produced by a blow on a ringing boulder was the product of interference between several subaudible resonant frequencies. That is, when struck, the boulder vibrates at several frequencies. None of these frequencies is audible, but the sum of the interfering and interacting frequencies produces a tone that can be heard by the human ear. The subaudible vibrations have unusual frequencies (cycles per second) and attenuation (duration) for rock materials. Faas and Flocks also pointed out that the tones produced showed some correlation with boulder size.

We became interested in the problem through Faas and several teaching trips to the fields. Our field observations, added to Faas's sonic data, led us to a tentative hypothesis about the ringing boulders and eventually to a systematic study. The ringing boulders often spall (flat chips break off from the surface) when tapped lightly with a hammer. These spalls are surprisingly energetic, sometimes flying past one's ear with a humming sound. If a ringing boulder, which is very tough, is broken apart with a sledge hammer, it soon stops ringing altogether. Such breaks produce a peculiar surface pattern often seen in metals that have broken under large internal stresses. The boulders are unusually absorbent when wet. The outer inch or so of most of the boulders is noticeably altered in color and texture by weathering, and that altered zone soaks up water at a surprising rate.

Formation of a workable hypothesis, one that would form a solid foundation for research, is a critical matter in such a project. If the hypothesis is carefully thought out, it has an organizing effect on the whole effort. It is necessary to begin with a question—in this case: Why do the ringing rocks ring? The next step is to assemble all available information. This information can then be used to weed out the most likely answer or answers. Once a test hypothesis has been chosen, it is important to state it in the simplest and most concise terms possible. When that is done the questions needed to test the hypothesis become clear almost automatically. If the questions are answered in the affirmative, that is, if the correct hypothesis was chosen, then interpretation of the impact of the hypothesis on other, related questions is the final step.

In the case of the ringing rocks the process went something like this. Question: Why do the boulders ring? Information: The rocks were very energetic (spalling, fracture type); they resonated at a frequency different from the "natural" frequency; and there was something unusual about the fields' dry and exposed environment that seemed to produce or at least localize the abnormal resonance. Our search for a hypothesis seemed to lead back each time to one focus: How can the resonant frequency of rock be altered by a natural process?

All materials have what may be called a natural resonant frequency. That is, because of its atomic structure any material has one vibration frequency at which it resonates, or responds harmonically, to its own vibration. Natural resonance is a well-defined concept that has been thoroughly studied by metallurgists and engineers. The natural resonance of crystalline substances, such as minerals, depends primarily upon the strength of the atomic bonds and upon the atomic spacing.

The most feasible way of changing the resonant frequency of a material is to subject it to an elastic strain. Elastic strains are impermanent changes in the shape or size of a body. That is, if a body is elastically strained and the stress is removed, the body returns to its original shape or size. Elastic strain involves no breaking or rearranging of atomic bonds. Rather, the material changes shape by what can be thought of as stretching the bonds. When the stress is removed, the bonds rebound, returning the atomic structure to its original position. While the bonds are stretched, however, the resonant frequency of the material is changed because the atomic spacing is altered. A good example of this principle is the old musical saw act from vaudeville days. The musician changed the tone of the saw by bending (elastically straining) the saw while he stroked it with a violin bow.

Now we can modify our original question: Why do the ringing rocks ring? If elastic strain is the most easily visualized means of changing the resonant frequency of a body, the question can be rewritten: Do the ringing rocks ring because they are somehow under stress?

We decided the best way to find out would be to dissect the rocks and see if they showed signs of stress. This technique assumes that any body subject to stress over a long period of time will reach equilibrium, a balanced state, if it does not break. Ice in a glass bottle provides a familiar analogy. As the ice expands, tension increases in the glass. The forces are balanced—until the glass breaks. Before the glass breaks, it is possible to measure the stresses in the ice-bottle system indirectly. Melting the ice removes the stress; then the return of the bottle to its original size and shape can be measured. Because the force needed to "stretch" glass (this is known as its elastic constant) is known, it is easy to compute how much stress was required to stretch the glass by the measured amount.

Rocks are more complicated than ice in bottles because the balanced forces exist in the same object. But the stress regions tend to lie parallel to the object's surfaces when equilibrium is complete. So by slicing off sections parallel to the surface, we can measure the change as the core returns to its original size and shape. We also have to know the elastic constant of the material involved, but this is either available in published reports or can be easily measured in the laboratory. Then we can say how much stress was present in the rock.

To use this technique we sawed the ends and sides from boulders, leaving only central cores. We carefully measured the cores many times over a long period of time to determine whether any change of dimensions took place. The first ringing rock core we measured was almost eleven inches long. A relaxation (contraction) of almost 1/500 of an inch was observed.

That measurement exceeded our wildest estimates and led us to believe that the technique of measurement was introducing a large amount of error into the data. Therefore we decided to use electronic measurement with foil strain gauges. These tiny strips of metal and plastic can measure extremely fine changes of shape on a surface when coupled with the proper electrical receptors, amplifiers, and strip-chart recorders. They have the additional advantage of constantly recording the change in shape of the body as time passes, producing a new kind of information, as well as greater accuracy and precision.

The sensitivity of foil strain gauges is fantastic. While testing and calibrating the equipment we glued a strain gauge to an old core of very hard diabase, about one and a half inches on a side and nine inches long. Just for fun, one of us placed the core over his knee and tried to bend it. The recorder dutifully recorded 1/100,000 of an inch strain.

Foil strain gauges showed that the cores from ringing boulders relaxed an average of approximately 1/10,000 of an inch per inch of specimen length. Nonringing boulders from outside the fields showed no relaxation. In most cases total relaxation required between seventy and eighty hours. Early relaxation was rapid, followed by a long period of gradual change of specimen shape. Occasionally, the gradual tapering off was interrupted by sharp fluctuations; in two cases these could be correlated with the formation of visible fractures.

Core relaxation as time passed was plotted as a curve on a strip-chart recorder. The various forces that can change the shape of a body tend to produce curves that have characteristic shapes, or "fingerprints." The curves from the ringing boulders compared well with curves for a type of relaxation metallurgists call after-working, or anelastic strain. In the field of rock mechanics the same phenomenon is called recoverable creep.

Normally the strain magnitudes measured indicate the result of tremendous stresses. By using the experimentally determined elastic constants for diabase, published by Francis Birch, and the relaxation figures that we obtained, we could compute theoretical values for the stresses stored in the rock. For some rocks these values were as high as 15,000 pounds per square inch. Such large stress values are particularly perplexing in boulders lying in an open field acted upon by no observable external forces.

Creep, or anelastic behavior, is a particularly logical explanation for this apparent paradox. It can produce fairly large strains at relatively low stresses, with the important qualification that the stresses be applied over a long period of time. Therefore, the large stresses seemingly indicated by the computation based on Birch's short-term constants are not particularly relevant. The strains observed seem to be the result of stresses applied over very long periods of time.

The origin of the stresses was determined by more conventional geologic techniques. We prepared thin sections from several areas within each boulder and examined them under the petrographic microscope. The outer "skin" of the boulders is, as already mentioned, quite permeable to water. Water combines chemically with minerals and changes them in the process called chemical weathering. New minerals, usually clays, are often produced when the original minerals are broken down by water.

Microscopic examination showed that chemical weathering had in some cases advanced two or three inches into the boulders. The most chemically susceptible mineral in diabase is pyroxene. The pyroxenes in the diabase were completely removed at the surface of the boulders. Near the surface the pyroxenes were completely altered to a type of clay known as montmorillonite. Alteration of pyroxenes to clay diminished as distance from the surface became greater.

The source of the stresses in the boulders was clear at once. The change from pyroxene to montmorillonite produces a volume change. If a given volume of pyroxene is weathered to montmorillonite, the montmorillonite occupies more space than the original pyroxene. The expansion of many grains of pyroxene during weathering produces an expansion of the outer shell of the boulders and a corresponding tension in the core. The strain resulting from the tension raises the resonant frequency from its natural value to that observed in the ringing rocks.

Stresses caused by weathering exist in many rock types. In most, the stresses cause a surface sloughing known as exfoliation. The combination of unusual strength and slow production of stress allows the diabase to accumulate stresses of great enough magnitude to produce the ringing effect.

The arguments presented up to this point are entirely internal: they all come from a study of the boulders. Now we needed some external confirmation to make the argument tight. Relaxed cores, which no longer rang, were fitted with steel grips. When restressed in an engineering tensile tester to 10,000 pounds per square inch, the cores rang clearly. With this reasonably independent confirmation of the association between strain and ringing, we were satisfied that our original hypothesis was confirmed.

We also wanted to know the role of the special boulder-field environment in producing the ringing effect. Apparently the answer lies in a very delicate balance between weathering rate and rock strength. The boulders in the fields are not buried in soil or shaded by overhanging trees. They are wet only for a short period following a rain or snowfall. This makes the chemical alteration of the minerals and the stresses produced by those alterations accumulate at a very slow rate. Frost action, the breaking of rock by expanding ice, is probably also minimized by the short time water stays in the system. Long periods of time for the establishment of a state of stress equilibrium are thus provided.

Where the forest encroaches on a boulder field, the shade slows evaporation, moisture is retained, weathering proceeds faster, and soon the rocks no longer ring.

Those boulders outside the fields exist in a different environment: they are shaded and usually lie on or in water-retaining soil and forest litter. Weathering and frost action proceed much more quickly. Time for adjustment of the stresses in the rock to an equilibrium state is insufficient, and the boulders "crack up."

This conclusion explains why boulders removed from the field stop ringing. If left outside in a rock garden or other shaded spot the boulders are soon overstressed and break up. Ringing rocks kept dry in geologic collections continue to ring indefinitely.

The delicacy of environmental controls on the ringing effect can be illustrated by examining the edges of the boulder fields: the zone separating boulders that ring from those that do not is relatively sharp. The boundary usually lies several feet within the field. The position of the boundary was a puzzle until a botanist friend accompanied us to the site one day. His chance comment about the plants growing along the *shade line* from the bordering trees struck home. The boundary of the ringing boulders area corresponds roughly to the average position of the shade produced by the larger trees about the edges of the field. More shade means less evaporation and thus more moisture retained. Enough apparently, to disrupt the balanced processes that cause the boulders to ring.

We therefore propose that the answer to the ringing rocks lies, not in witchcraft or ancient ruins, but in a very subtle and delicate interaction between earth materials and environment over very long periods of time. These are things that cannot be observed in terms of man's unaided senses. The concept of the immensity of geologic time is peculiar enough to most people. The measurements necessary to detect and measure the data presented here are impossible without complex instruments. Faced with phenomena for which there are no observable causes, it is completely logical that supernatural explanations should be proposed. Such proposals are the product of the same curiosity that has produced all sciences, especially the natural sciences.

The face of the natural sciences has been changing radically over the past few years, and the proposed solution to the ringing rocks problem presented here is a good example of that change. Once, people like B. F. Fackenthal were naturalists. Their approach to problems could be broad and general because the volume of material to be mastered in the natural and physical sciences was relatively small. Then came the "information explosion." It has become impossible for a man to be acquainted with all the knowledge in his own field, much less in many fields at once. The Renaissance man seems to be lost. Workers with narrow specialties are the rule. This situation has led to many scientific impasses. Problems involving natural systems are often simply too broad and complex to be managed by one man's education.

The solution appears to lie in the multidisciplinary approach. The team we put together to solve the mystery of the ringing rocks included three physicists, two engineers, four geologists of varying specialties, two biology students, and one botanist. Once we all got together, those rocks didn't stand a chance.

THE FLORENTINE CODEX

A sixteenth-century friar's tale records, in words and pictures, the daily life, customs, and beliefs of the Aztecs

by Herbert R. Harvey

Had the main challenge to the Spanish conquerors of ancient Mexico been merely to achieve military victory, we would today know much less about the civilization of their Indian adversaries. While the natives capitulated to Spanish rule after the fall of Tenochtitlán in 1521, spiritual domination required many decades, indeed centuries, to achieve. One by-product of the church's long effort to convert the natives to Christianity, however, was a corpus of written descriptions of the Indian cultures. By far the greatest and most comprehensive of the early clerical accounts of native life was Fray Bernardino de Sahagún's *General History of the Things of New Spain,* or as it is better known, the *Florentine Codex.* With the publication of Book 6, Arthur J. O. Anderson and Charles E. Dibble have completed and made available for the first time a full translation of the Nahuatl text of Sahagún's monumental work.

FLORENTINE CODEX: GENERAL HISTORY OF THE THINGS OF NEW SPAIN. BOOK 6: RHETORIC AND MORAL PHILOSOPHY, by Fray Bernardino de Sahagún. Translated by Charles E. Dibble and Arthur J. O. Anderson. *University of Utah Press, $13.00; 260 pp., illus.*

The *Florentine Codex* is a compendium of ethnographic and historical facts on the Nahuatl-speaking peoples of the Valley of Mexico as they existed at the time of the Spanish Conquest and during the early colonial era. It is divided into twelve books, of which the first six are primarily concerned with matters of morality and religion, while the remainder deal with a variety of topics, such as the political system, economics, trade, history, natural history, and the conquest of Mexico (from the Indian viewpoint). The work forms an integrated whole, and often a single topic may be dealt with in a number of different books.

Sahagún was a Franciscan friar, who had come with others to Mexico from Spain in 1529 to convert the Indians to Christianity. Nahuatl, plus closely related dialects, was the principal language of the region, and the learning of it was a necessity for the early missionaries. Perhaps because of his ability with the language or his personal interest in native culture or both, Sahagún was ordered by his superiors in 1557 to prepare a treatise in Nahuatl that would be useful to other missionaries in carrying out their conversion of the Indians. Sahagún, in fact, began his preface to the work with the observation that a doctor could not prescribe treatment without a knowledge of the malady or its cause. It follows that a thorough understanding of the customs and beliefs of the Indians was deemed essential to facilitate conversion. At the same time, he also explicitly determined to prepare a document that would in itself be the foundation for a dictionary of the language, since a corpus of literature, classics for example, was not available for the purpose. To some extent, therefore, his linguistic objective influenced the style for his ethnographic description.

The *Florentine Codex* was the end product of a long process of planning, inquiry, writing, and re-

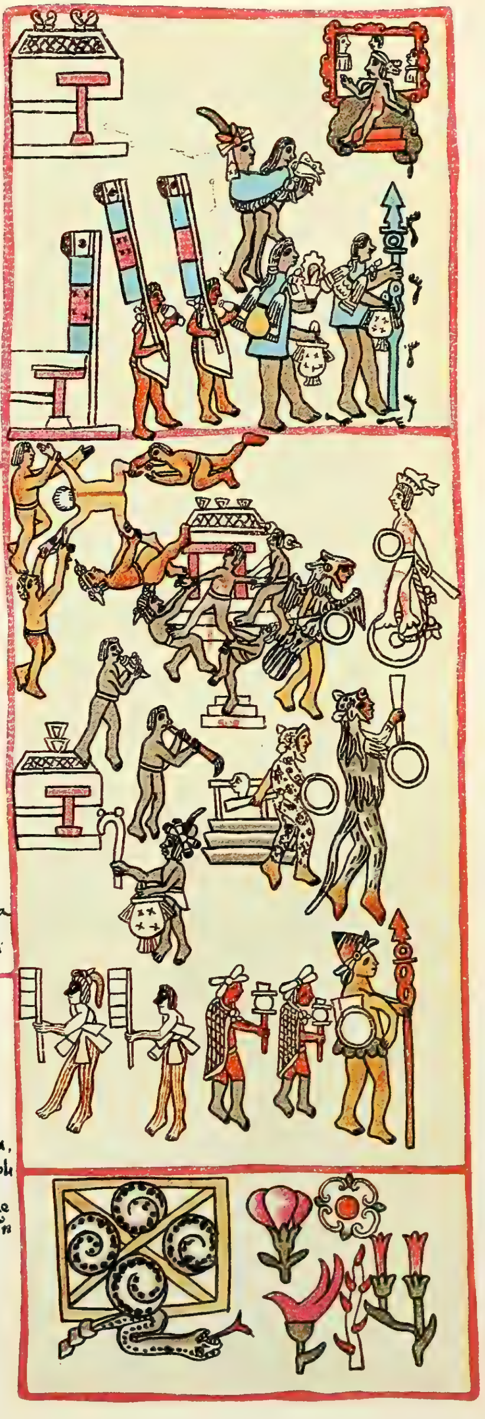
Ynic .ij. ipan mitoa yminilhuiuh, inte
teu.

Quavitleoa, ynipani, ilhuiquixtililoya, intla
lloque: ioã nextlavaloya, ỹnovia tepeticpac
mochitlacatl inmacevalli: ipan vmpevaya ỹ
cecempoallapoalli ynicexiuitl, auh macuilil
huitl yaanenvntemj. Yn.v. ilhuitl quiçaya
ipan iccempõvitl hebrero: inipan ilhuitl miquia
inpipiltzitzinti motenevaya tlaçateteuh me
ỹ vmpa tepeticpac: ioã incalpã novian moq
quetzaya inmatlaquauhpitzaoac, itechmopi
piloaya inamatl, holtica, tlacuiloli, motene
vaya amateteuitl. Auh iniquac yeonaquiz
tonatiuh. teteuh xallaquilo, vnca
mochi quivalcuja, ycalpã mochivaya teteuitl,
invnca diablo itvalco, muchintin qualcuia in
macevalti, inpipilti, inteteuctin, ipãpa ỹmo
tenevaya teteuh xalaquilloya: ioã tlayavalo
loya, auh intlatloca vevetq teyacanaya valte
nana michivia ynictlayavaloloya: quiqueqch
panotihui ỹ inteteuh.

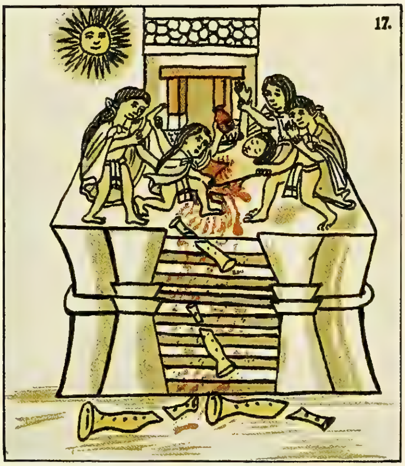
vncãtone
vaya in
tepeticpac
icomox
tlavaya
maceval
ti

Ynic ontetl tlacaxipevaliztli iquac inmiquia mamalti
ioã tlatlacoti, quixipevaya, ioã iquac nemja, in
xixipeme, inquimaquitinenca inimevayo ỹoq
xipeuhq: ioã onca qualoya ynvilocpalli .i. neca
tlaxcalli, ioã olchicalli, quiquaya ỹtetevatzitzin.
Yni, ilhuitl quiçaya, ypan iccempoalli vnchiqua
ce hebrero, ynipanj iquac miquia, ioã quixipeva
ya, mamalti, ioã tlatlacoti, Auh ynimoztlayoc:
noiquinin temallacac, quinquetzaya, oncã quiva
vanaya quixipevaya Auh inimevayo oquixipeuh
q cequintin tlaca conmaquiaya, cempoalilhuitl ipã
mitotitinenca: ipan tequiquixtiloya inevatl, q.n.
mochintin valquiçaya inmacevalti vallalataya:
ioã inivipitlayoc çacapã valnemanalo. Jn.y. iquac
yancujcã neaquiloya ynimevayo tlaca, ynicmitoa
çacapã, camotzetzeloaya ỹçacatl, inipã quivalma
naya xixipeme, ioã moteneva ayacachpixollo auh
ynic mochivaya cavncã vmpevaya inetotiloya im
chã diablo canoquequi tlacatl mochitlacatl yyaya
cach inipã mitotiaya inpipilti inmaçevalti auh
invmpa tianquizco vmpa onechicavia inixqch
macevali mochitlacatl yyayacach ynipã mitotiaya
Ynipã ilhuitl icempoalilhuitl mochitlacatl valcuj
catequitia ynivyollo altepetl, mochitlacatl icmochi
chivaya ynica, çeçeyaca, ynechichiuh.

Ynic etetl motenevalocoztontli, iquac xochimanaloya:
ioã covaixcalmanaloya. Ynic mitoaya xochimanaloya,
yehica inixquich yancuicã cueponja, nepapa xochitl
ictlamanaloya. Auh inic moteneva covaixcalmana
loya: yehica incocoa, tleco, moxcaya inictlamanalo
ya ipan motecaya inventli ynic vntlamanaloya yni
chã diablo Jnilhui Auh intla aca caciz covatl aya
mo quiquaya, quinj quac inocovaixcal manaloc iquac
vel quiquaya, Cano inhqui xuchitl ayayac vel quitequia,
achtopa ictlamanaloya Jnjn ilhuitl quiçaya ipã iccaxtoli
omey marco. Yoã mitoaya hevatlatillo inicmitoaya
hevatlatilo, iquac inçempoalilhvitl oneaquiloc ynime
vayo, tlaca, çatepã contlaya, in vztoc contocaya. con
tlalpachoaya vncã palanja ——.



The illustrations are reproduced from
the Paso y Troncoso color edition of
the *Florentine Codex*, 1905-07.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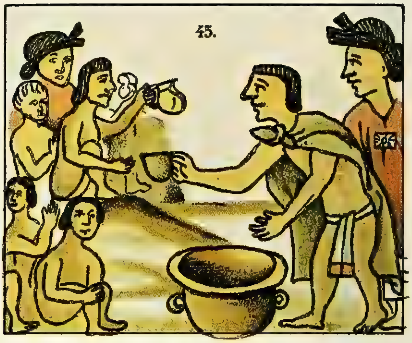
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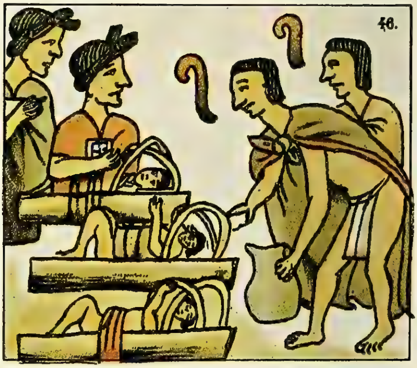
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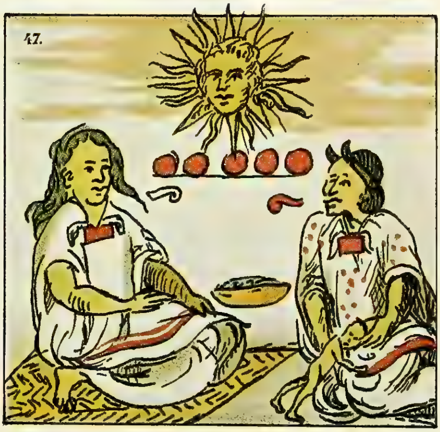
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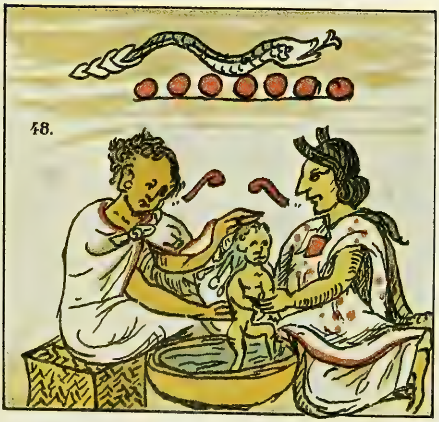
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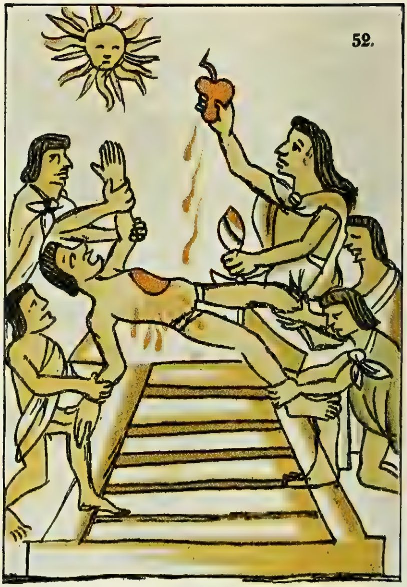
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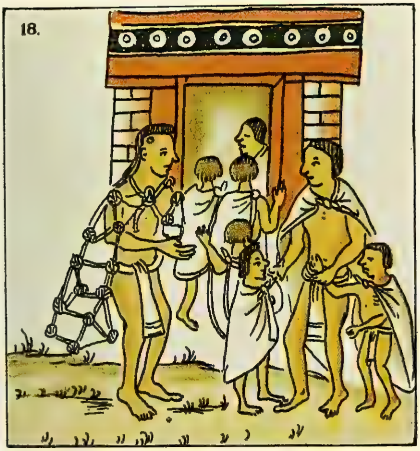

18.

17. Festival of Tezcatlipoca: the god's chosen impersonator offers himself for sacrifice at the temple.

47. A mother consults with a reader of day signs.*

48. Seven Serpent was a particularly favorable day for bathing a newborn child.*

45 and 46. After the childrens' ear-piercing ceremony, all exchanged wine and the babies were given food dipped in wine.*

52. For human sacrifice, victim was held by priests, his chest opened with a flint knife, and the throbbing heart ripped out and offered to the sun.

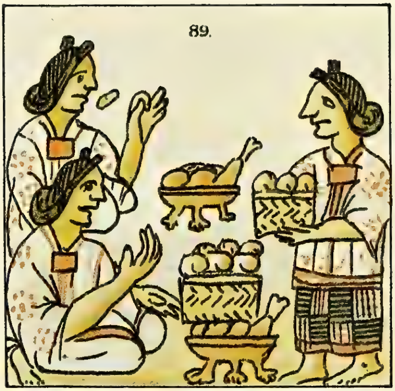
18. Small boys lived together in the young men's house.

89. After the bathing of a newborn, the parents gave a great feast.

19. Musicians with characteristic instruments, rattles and drums.

21. Ceremony to the god Xipe Totec: a dancer wearing his victim's flayed skin stands by as Montezuma receives a foreign delegation.

*Scrolls near mouths indicate speech.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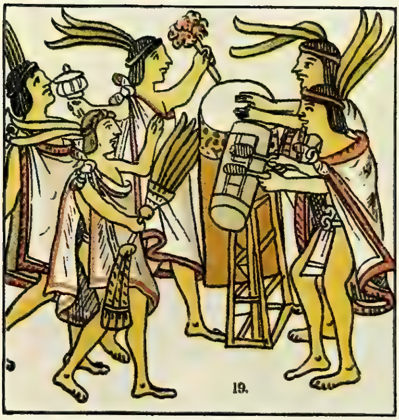
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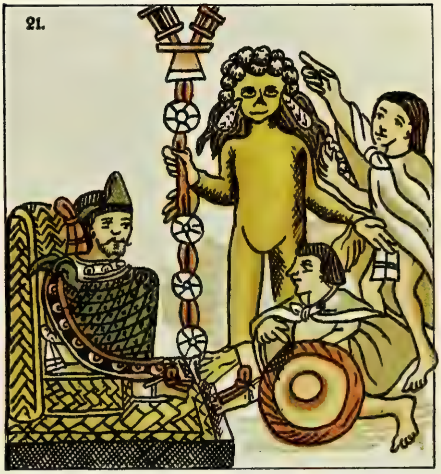
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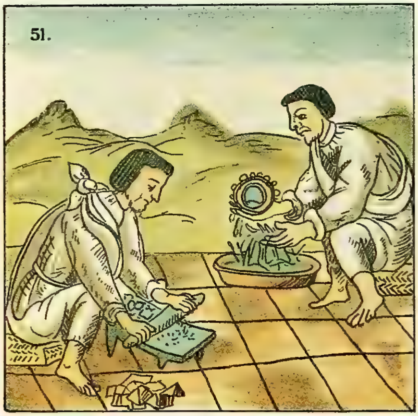
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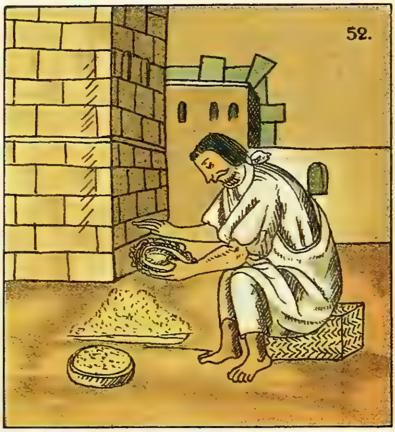
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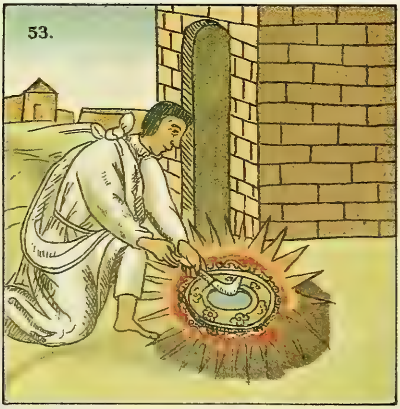
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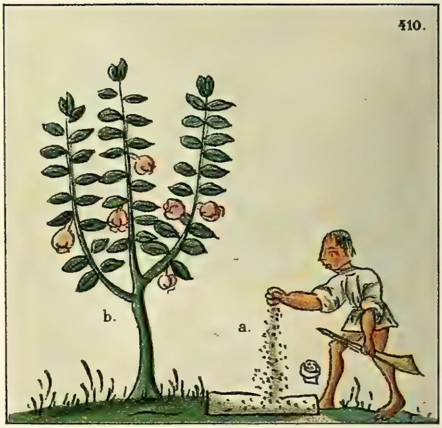
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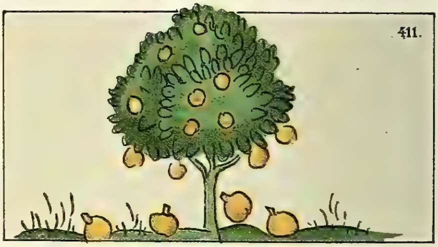

411.

Casting Gold Objects:

51. After firing, the object was burnished with alum and then refired.

52. After refiring, the gold object was rubbed with a mineral to make it more yellow.

53. The gold object was polished until it glistened.

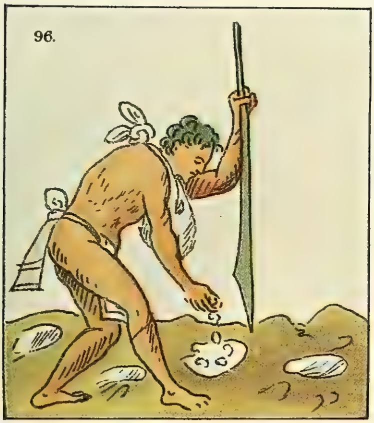
Food Production:

410. (a) Planting (b) Fruit tree

411. Sapodilla, an edible fruit

96, 97, 98. Planting, cultivating, and harvesting corn.

99, 100, 101. Harvesting, threshing, and storing amaranth.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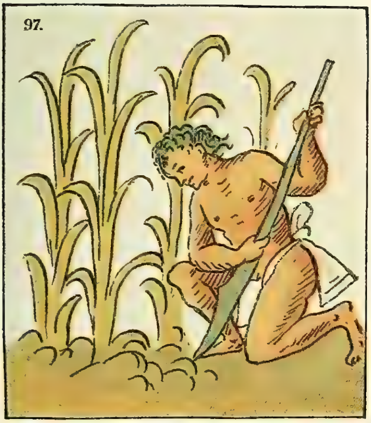
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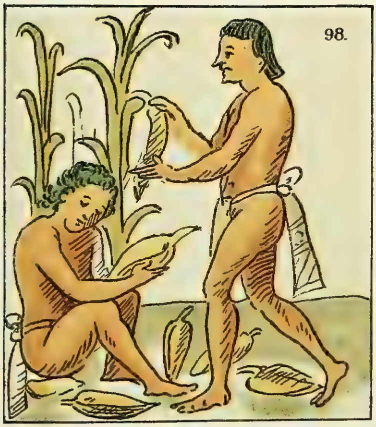
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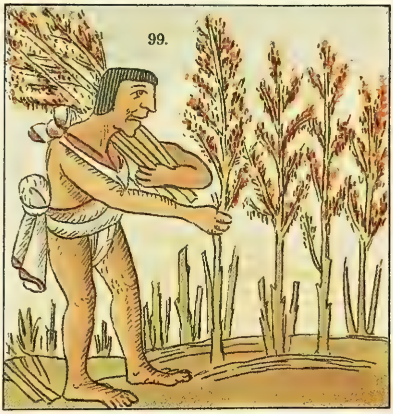
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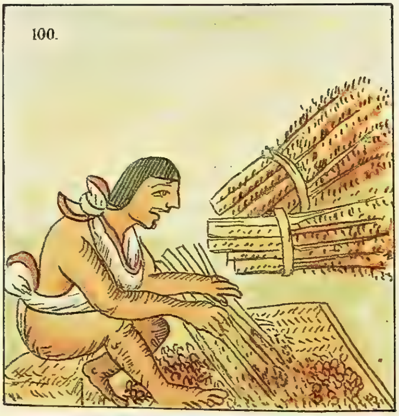
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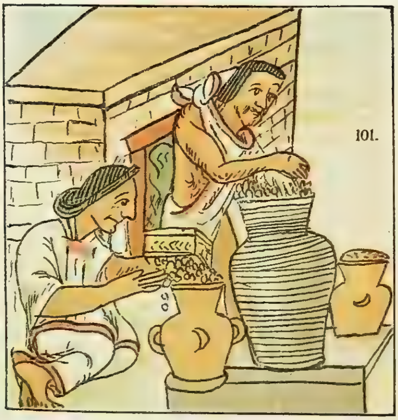
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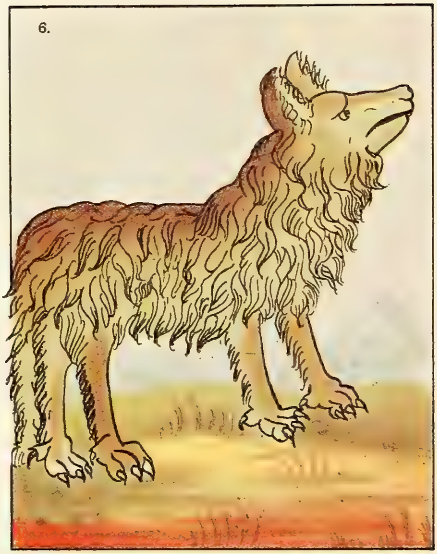

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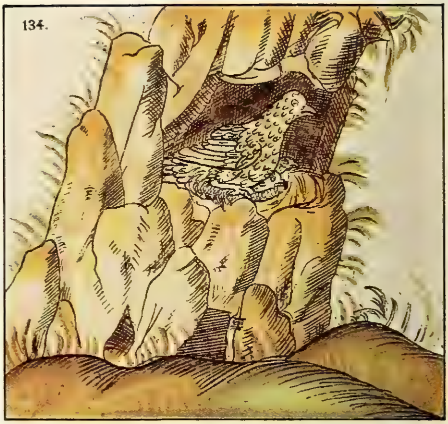

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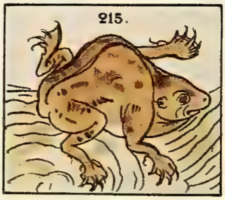

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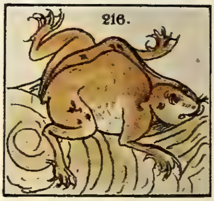

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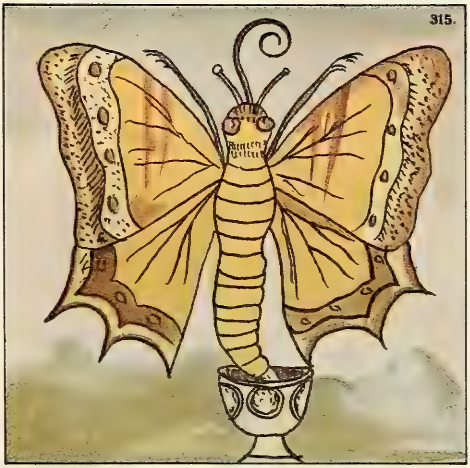

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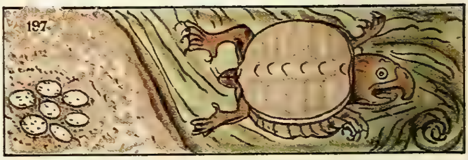

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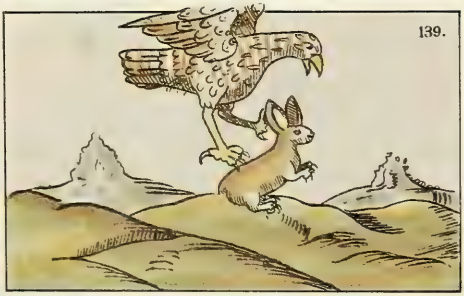
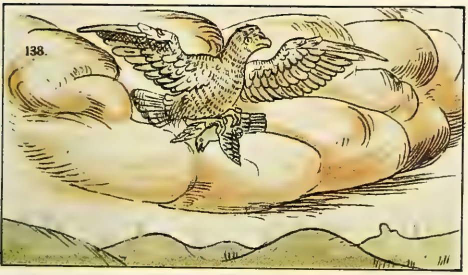


139.

6. Wolf or fox
315. Butterfly
139. Falcon with rabbit
134. Falcon
215, 216. Frogs
197. Turtle
138. Falcon
193 and 194. Varieties of sea fish
171. Varieties of the native turkey
246. Rattlesnake
5. A variety of ocelot (?)
205. Lizard
219. (a) Shrimp (b) Larva of dragonfly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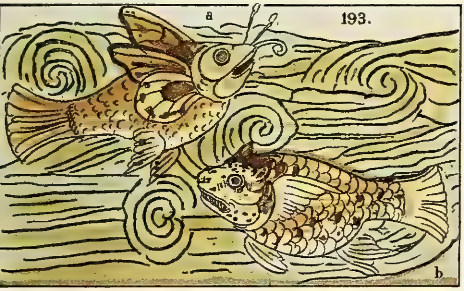
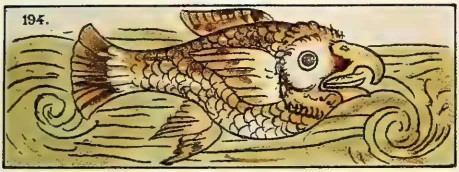

a
193.
b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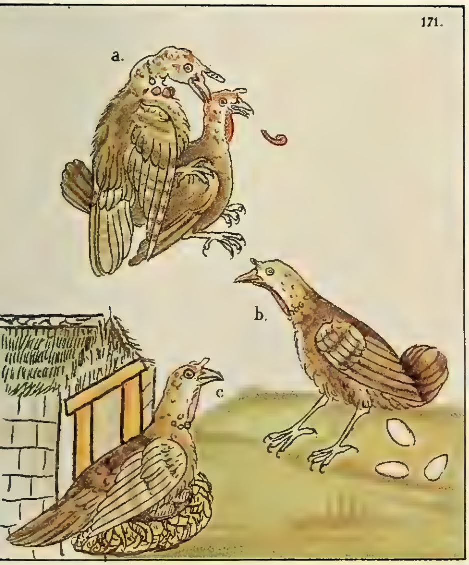
171.
a.
b.
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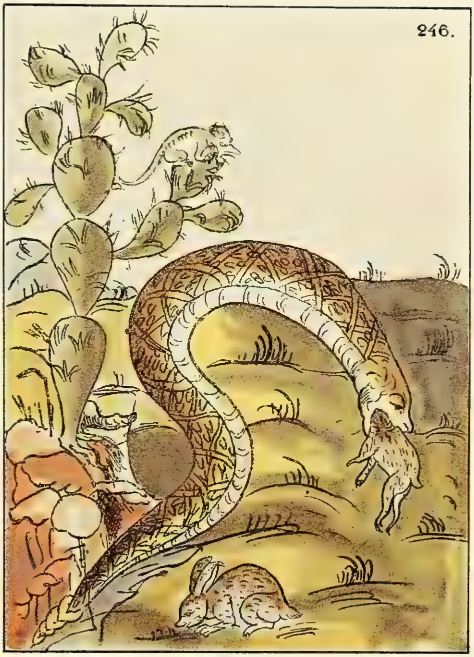
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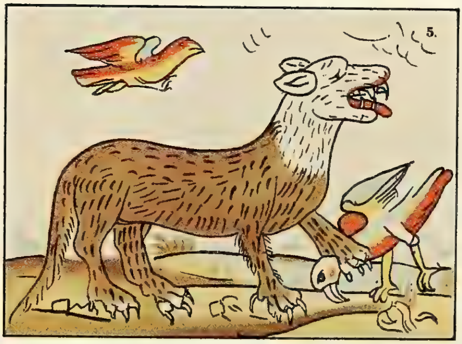
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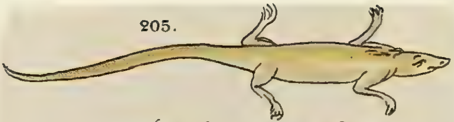
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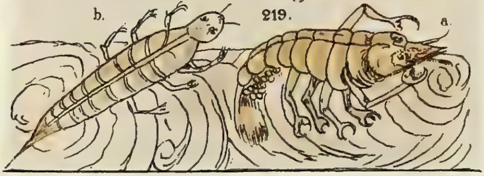
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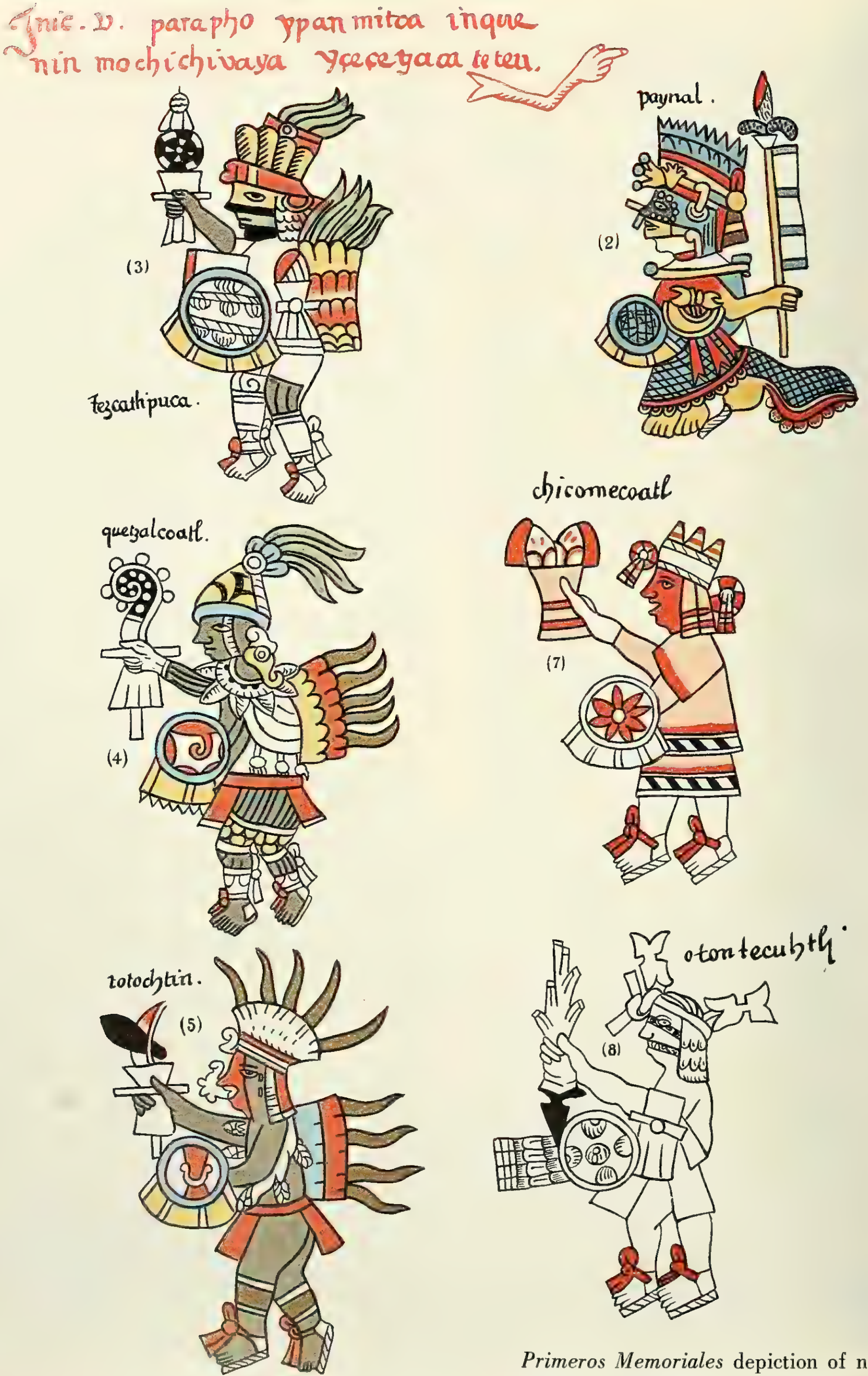
a.



Inic .v. parapho ypan mitoa inque nin mochichivaya yçeçeyaca teteu.

paynal.
(2)
(3)
Tezcatlipuca.
quetzalcoatl.
(4)
chicomecoatl
(7)
totochtin.
(5)
otontecuhtli.
(8)

Primeros Memoriales depiction of native gods in the Tepepulco manuscript.

writing. The project lasted more than ten years, and was carried out with the aid of many trilingual (Spanish, Latin, and Nahuatl) Indian assistants and numerous native informants. Beginning in 1558, in the town of Tepepulco, a few miles to the northeast of Mexico City in the Province of Texcoco, Sahagún first prepared a questionnaire and then assembled a dozen of the oldest, most learned men of the Indian community to serve as informants. They responded in the manner familiar to them—by preparing a series of drawings and then explaining them. Their responses were recorded by Sahagún's native assistants. The work continued through 1560, and the result was a document now known as the *Primeros Memoriales*, which is on display in the National Palace in Madrid. This document, the first, preliminary version of what was to become the *Florentine Codex*, was divided into four main sections: (1) and (2) religious matters, (3) politics and the state, and (4) human affairs.

From Tepepulco, Sahagún moved to Tlatelolco, the old market center of the Aztecs, now part of Mexico City, where he resumed work on the manuscript in 1564–65. His method was the same—assembling a group of *ancianos*, who were respected for their knowledge, to comment on the drawings of Tepepulco and to discuss his questions. A few more pictorial descriptions were added to the corpus. The result of this effort was an enlargement of the earlier work and the addition of subject matter on natural history. The latter document is also in Madrid, at the Royal Academy of History.

From Tlatelolco, Sahagún moved to Mexico City, where he completed the final version of his work, the *Florentine Codex*, between 1565 and 1569. His earlier outlines underwent several additional revisions; some sections were subdivided and new topical coverage was added: rhetoric and moral philosophy, and the Conquest. The final, twelve-book version, a clean copy without the marginal notations of the previous drafts, is in the Laurentian Library in Florence.

In 1570, Sahagún's funds for assistants were cut, and his ambitious enterprise came to a halt. For more than two centuries after his death in 1590, the work remained unpublished, largely unknown. During his lifetime, he had made two Spanish versions. The *Florentine Codex* itself was drafted in two parallel columns, Nahuatl and Spanish, with a pictorial supplement, adapted from the earlier drawings of Tepepulco. Curiously, the Spanish is not a direct translation of the Nahuatl, but rather, more of a paraphrasing, and at times a supplement, since in some instances a point of substance treated in one is omitted in the other. The other Spanish draft, which may well antedate the Florentine draft, is closely similar but not identical. It was from the latter Spanish version, the Tolosa manuscript, that the first publication of Sahagún's work was made in 1829–30. Since then, a number of Spanish editions have been published, as well as a facsimile edition issued in 1905–07 with colored plates on the codex, and translations of sections of the Nahuatl text of all three documents. Dibble and Anderson's is the first complete translation of the Nahuatl text of any of them.

In completing the translation, Anderson and Dibble worked together for more than twenty years. Book 1, Part 2, *The Gods,* was published in 1950. With the exception of Books 4 and 5, *Soothsayers* and *Omens*, which are bound under one cover, the individual volumes have appeared at random intervals, and not in numerical sequence. Thus, Book 6, *Rhetoric and Moral Philosophy*, was reserved to last because of its length and difficulties in translation. The final volume, Book 1, Part 1, yet to be published, will include a Preface, Table of Contents, Bibliography, and General Index.

In publishing the *Florentine Codex*, Dibble and Anderson have preserved the basic format of the original document: two parallel columns, one in English, the other in Nahuatl. They have also reproduced in black and white the Paso y Troncoso copies of the original drawings that accompanied the text. Moreover, their strategy of translation has been to preserve, as much as possible, the flavor of Sahagún's writing. They have used a device of employing archaisms, thus giving the translation a sort of King James quality. While it is not easy to judge the accuracy of translation, it must have been a tremendous task, for it took the authors twenty years to complete it. As for their translation, they have obviously exercised utmost care in their search for meaning. They continuously cite Sahagún's Spanish text; whenever possible, translations by others of the same passage are noted, and they frequently discuss in footnotes alternate meanings for particular terms or concepts.

While the translation is one thing, understanding and interpreting the content is quite another. Much of the *Florentine Codex* is straightforward description—of the market in Tlatelolco, for example, or the attributes of the different gods or the kinds of wild animals found in the realm. At the time of the Spanish Conquest, however, the Valley of Mexico was composed of a number of city-states, each with a different history, each with a diverse ethnic background. Sahagún is not always clear as to which he is describing. He started his work in Tepepulco, a minor town of the Culhuas, and finished it in Tenochtitlán (Mexico City), the capital city of the Aztecs. There were language differences between these places, which are apparent in the several manuscripts. Between the towns of the Valley of Mexico there were cultural differences as well. At the time, Texcoco was recognized by both the Spaniards and the natives as having been the center of the arts, that is, the cultural capital of the Valley of Mexico. A factor that complicates the problem even more is the difference between the nobles and commoners, which is known—in great part from Sahagún's work—to have been vast. So, while it may often be apparent to whom

Continued on page 82

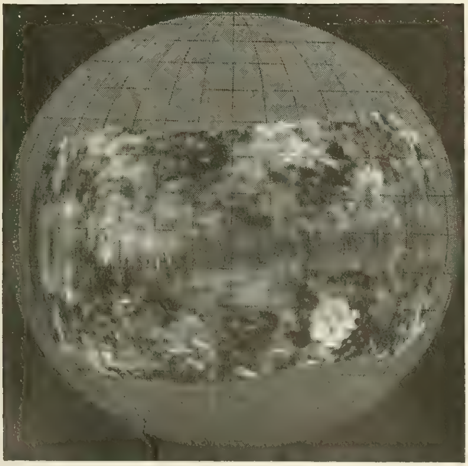
Sky Reporter

Mapping Venus with Radar Our neighbor Venus, known to generations of science writers as "mysterious" and "cloud shrouded," is slowly giving up her secrets to powerful radar beams that can penetrate her veils. Reproduced here is a radar "map" of one hemisphere on which surface features are clearly present.

The resolution of the map (about 50 miles) is roughly twice that of the naked eye looking at the moon. Just as naked-eye observation of the moon does not reveal what kind of features you are seeing, so the radar map of Venus tells you only that some areas reflect more of the incoming beam than do others. The brightest feature on the map is Alpha, the white area in the lower right portion. But the resolution is not good enough to reveal whether Alpha consists of mountains, craters, boulder fields, extensive lava flows, or some other geologic formation. The best that can be said about it is that it is about 600 miles across, has a "great deal of structure," and is brightest along its own lower left edge.

Other, much smaller bright spots appear on the map, mostly in the left-hand portion. Some of the dark areas appear to have discrete roundish shapes; they are about 150 miles across. A few of the dark regions have bright spots in the middle.

To prepare the radar map, Richard Goldstein of NASA's Jet Propulsion Laboratory has been using a radio telescope ordinarily used to track spacecraft. He places a radar transmitter at the center of the 240-foot Goldstone antenna and aims the beam at Venus. An extremely complicated receiving system, and mathematical analysis of the results, produced the map shown here, which was first published in the journal *Science*.



Goldstein expects to be making improvements to the map by the time this appears in print. Venus went through inferior conjunction (passed between the sun and the earth) on November 10, and during this time of closest approach the radar beam flicked out again across 30 million miles of space. Goldstein also hopes to be able to use a more powerful beam, and thus obtain significantly better resolution.

Back to the Old Plotting Board Like scientists in other fields, astronomers spend their time not only discovering new things but also finding out that what they already know is not always true. The history of the discipline is studded with agonizing reappraisals of established facts.

One set of facts that undergoes periodic revision is the distance scale of the universe. Only in this century, in the lifetime of a single man, have astronomers expanded their horizons from a single island universe of a few thousand light-years diameter to a much larger home galaxy that is but one of billions flung across billions of light-years of space.

One method astronomers have used to measure distances in our galaxies or to nearby galaxies has involved a class of stars known as Cepheid variables. Relationships have been discovered between their light cycles and their absolute magnitudes (that is, their intrinsic brightness; it is expressed as how bright the star would appear at the standard distance of 32 light-years). Once you know the absolute magnitude of a star and can measure its apparent magnitude as seen from the earth, you can say how far away it is.

One type of Cepheid was particularly easy to use, because all stars of this type were thought to have the same absolute magnitude: 0.0. These were the RR Lyrae stars, named after the first of their class to be discovered in the constellation Lyra. They vary by about a magnitude, and complete a cycle from maximum to maximum in less than a day.

The problem is that while astronomers still believe that all RR Lyrae stars have the same absolute magnitude, they are not sure what it is. When the Variable Star Commission of the International Astronomical Union met in England last summer, the experts agreed that they were still far from an accurate magnitude.

Describing that meeting to the American Association of Variable Star Observers at their fall meeting, Dorrit Hoffleit of the Maria Mitchell Observatory on Nantucket said that current estimates of absolute magnitude range from 0.3 to 1.3, with 0.6 appearing to be the best guess.

She further explained that this range in absolute magnitudes for the RR Lyrae stars produces estimates for the distance from the sun to the center of the galaxy ranging from 19,200 to 32,000 light-years. The uncertainty will be reduced as better measurements are made of the motions through space of the closest RR Lyrae stars so that direct estimates of their distance can be made. Once a few distances are known accurately, astronomers will be sure of their absolute magnitude and the RR Lyrae variables will serve as mileposts wherever they are found.

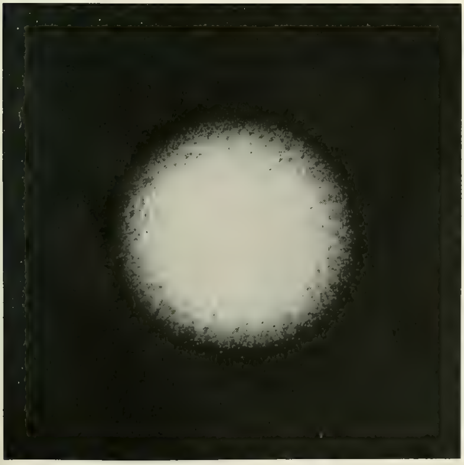
The Sun as a Variable Star Life on earth depends on a stable sun. If our nearest star were to flare up into a nova, life would be incinerated. If it were to dim, the ensuing cold would be lethal. In fact, however, the sun's total radiation appears remarkably constant. The paleontological record confirms this stability over the eons.

But the sun does vary. All radio operators are familiar with its 11-year cycle of sunspot and magnetic storm activity; during maxima, communications on earth can be severely disrupted. And it is becoming increasingly clear that the sun varies in other ways.

In the September isssue of the *Astrophysical Journal*, James A. Van Allen (discoverer of the radiation belts around the earth) and Jean Gibson reported on the X-rays emitted by the sun in 1966–68 (a time when the sun was "quiet") as measured by the earth-orbiting satellite Explorer 33 and the moon-orbiting satellite Explorer 35. They found the radiation to be essentially constant over periods of a day or so, but that it varied by a factor of six over a month's time.

Next they compared their findings with the records of the sun's radio emissions compiled at the Algonquin Radio Observatory in Ontario and found an extraordinarily close match. Maxima and minima lined up right beneath one another. The visible light from the sun is remarkably stable, but the radiation on both sides of the visible portion of the electromagnetic spectrum does vary substantially and in near unison.

Thus while the sun is more than stable enough to support life on earth, and is expected to be so for some time to come, it is by no means an unwavering beacon. Superimposed on its 11-year activity cycle lie significant monthly swings in both X-ray and radio output. Doubtless, as more detectors are flown outside the atmosphere, we will find still more variety in the activities of our nearest star.



Drawing a Blank on Uranus Believe it or not, this is the sharpest photograph of the planet Uranus ever made. The picture was made last March, when Uranus was 1.6 billion miles from earth (that's the closest it ever comes) and presented a disk just four seconds of arc across (1/450 the size of the full moon).

The photograph has a resolution of about a tenth of a second, ten times better than the limit usually imposed on earthbound telescopes by the churning of the atmosphere. It is one of a series taken with a 36-inch telescope floating under a balloon at 80,000 feet, well above most of the earth's atmosphere. Called Stratoscope II, the balloon-telescope rig is the work of Robert E. Danielson and Martin Schwarzschild of the Princeton University Observatory.

During the flight, pictures were also made of Jupiter, Io (a Jovian satellite), and the bright nucleus of a Seyfert galaxy. The pictures of Jupiter are being combined and a computer used to eliminate known blurring. They are expected to be released next year.

John P. Wiley, Jr.

Celestial Events

The moon is in the morning sky in mid- and late-December, reaching last-quarter on the 20th and new moon on the 28th. On New Year's Eve we shall see a slim crescent moon in the evening sky, waxing to first-quarter on January 4 and to full moon on January 11.

Planet watchers in late December and early January had best plan on rising early for their pleasures, for it is in the morning sky that three, Venus, Jupiter, and Mars, are dominant. All recent entrants into the family of morning stars, these three are gathering now in or near the constellation Libra. Mars is highest and dimmest of the three in the dawn; Venus brightest and lower than Mars; Jupiter lowest of the three and between them in brightness.

Saturn alone, among the bright planets, is in the evening sky. Located among the dim stars of Aries, it is well up in the east at sunset and sets well before dawn. Mercury is technically an evening star in late December, a morning star in early January, but it is hopeless to look for it.

December 16: Venus is at greatest brilliancy in the morning sky, with bright Jupiter nearby to the left, dim Mars to the right and more distant.

December 17-18: The star near the gibbous moon tonight is Regulus, in Leo.

December 22: The weak and dim Ursid meteor shower reaches maximum, but the last-quarter moon will brighten the sky for morning viewers.

December 22: The sun reaches the winter solstice at 1:36 a.m., EST, and winter begins in the Northern Hemisphere. The sun now stands farthest south over the earth, directly overhead at the Tropic of Capricorn.

December 24: The crescent moon this morning is in conjunction with Mars at about 8:00 a.m., EST. Mars is well above and to the left of the moon, but easy to find with the horn of the crescent as a pointer.

December 25: The crescent moon and nearby Venus and Jupiter present a striking view early on this Christmas morn before the rising of the sun.

December 28: Mercury, dallying in anonymity as an evening star, passes between earth and sun, in what is technically called inferior conjunction.

January 3-4: Venus and Jupiter have been getting closer to one another in the morning sky, as Venus races more swiftly eastward in its path through Libra. They are nearest at midnight on the evening of the 3rd, with Venus the higher and brighter.

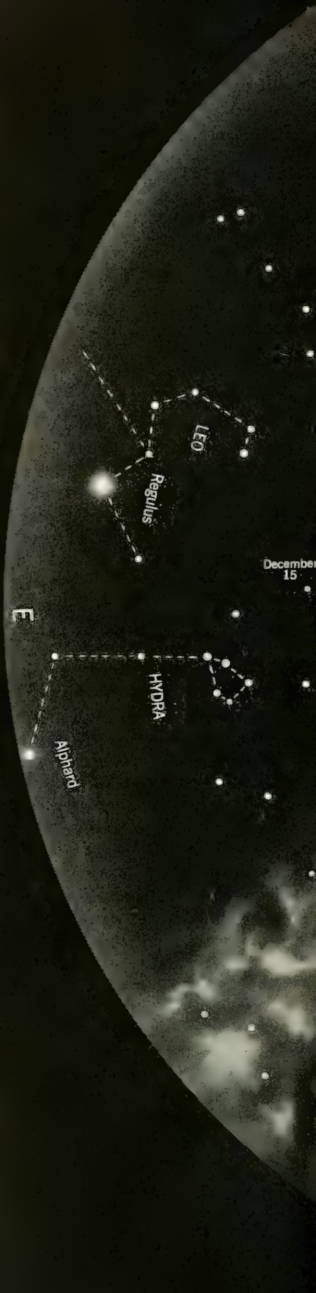
January 4: Today is the day the sun is nearest earth. We, in our orbit of the sun, reach perihelion, but, as you can see by the thermometer, it doesn't have much effect on our weather.

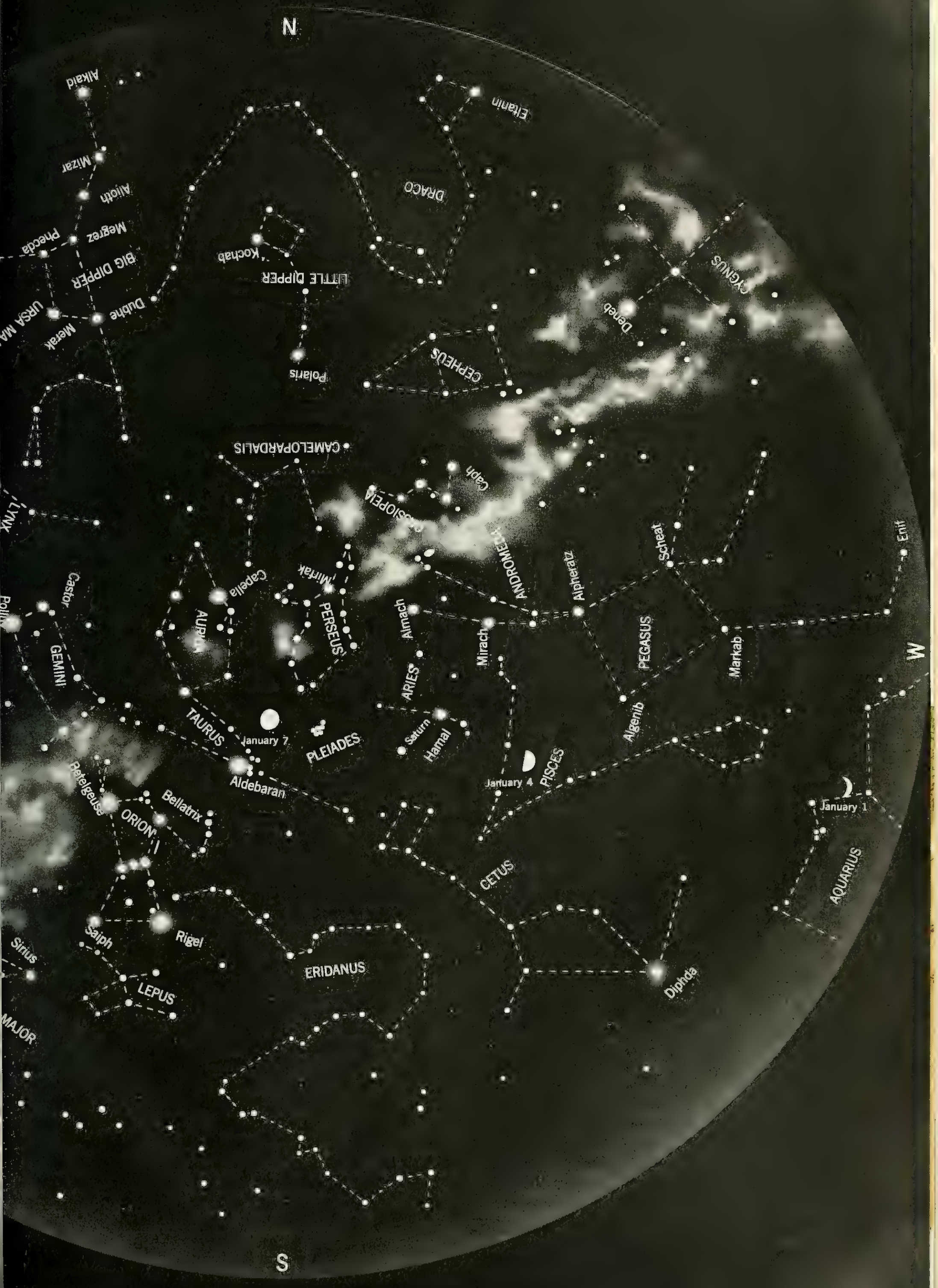
January 6: The bright object near the gibbous moon this evening is Saturn, rather lovely among the obscure stars of Aries.

January 14: The moon is back again near Regulus. After passing the star on the evening of December 17-18, the moon has gone once round the sky to return again to the same direction in space.

Thomas D. Nicholson

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky. The map is for 11:25 p.m. on December 15; 10:20 p.m. on January 1; and 9:20 p.m. on January 15; but it can be used for about an hour before and after those times.

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Alkaid
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Polaris
CYGNUS
Deneb
CEPHEUS
CAMELOPARDALIS
Caph
CASSIOPEIA
LYNX
Castor
Poll
Capella
Mirfak
AURIGA
PERSEUS
GEMINI
ANDROMEDA
Alpheratz
Scheat
Enif
Almach
Mirach
PEGASUS
Markab
W
ARIES
TAURUS
January 7
PLEIADES
Saturn
Hamal
Algenib
January 4
PISCES
Betelgeuse
Aldebaran
Bellatrix
ORION
January 1
CETUS
AQUARIUS
Saiph
Rigel
Sirius
ERIDANUS
Diphda
LEPUS
MAJOR
S

JOURNEY
TO
PULYKARA

In an era marked by moonshots and urban blight, wars and dissent, ten Australian Aborigines peaceably subsist as hunters and gatherers with time to spare

by Richard A. Gould

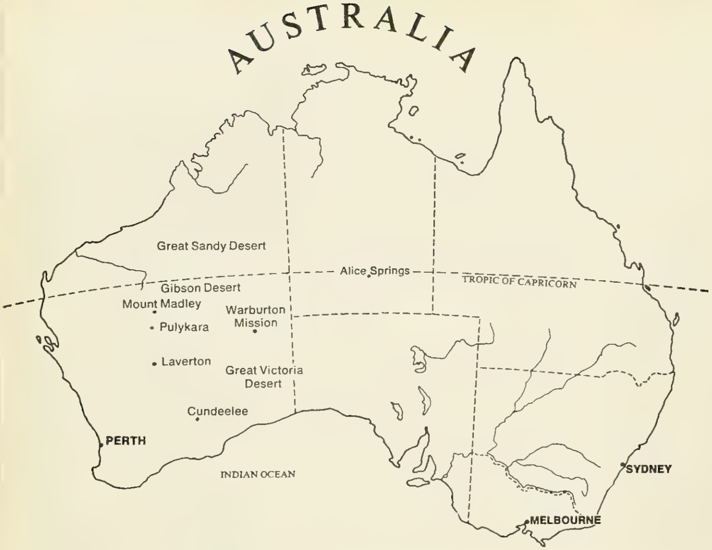
In November, 1969, I received a report of a small group of Australian Aborigines who had never seen Europeans. They were said to be living in the heart of the Gibson Desert, at a place called Pulykara, near Mount Madley, about 330 miles northwest of the Warburton Ranges Mission. They were discovered by Bob Verburgt, then a patrol officer for the Weapons Research Establishment at Woomera. This was four months after the astronauts had made their first moon landing, and it seemed to me then, as I am sure it did to many others, that there was no place left on earth that Western technology had not penetrated. It was ironic to think that while the rest of the world fought wars, built and destroyed cities, created art and literature, the ancestors of these people and the people themselves—as recent archeological evidence suggests—remained completely unaware and unaffected by it all.

At the time of their discovery, my wife and I were organizing an archeological field camp at the Warburton Ranges in Western Australia, and could not visit these Aborigines until our own project was well under way. Five months later, in April, 1970, we set out from Warburton in search of them.

Although our previous visit to this area in 1966–67 had provided the opportunity for us to live with and study a group of Aborigines who had formerly been to white settlements and had subsequently returned to the desert and resumed their nomadic existence, we had never before encountered anyone so isolated from, or untouched by, Western culture. The Aborigines living at Warburton, many of whom came from areas adjacent to the Mount Madley region, admitted that they, too, did not know who these people were—a remarkable admission from people whose network of kin relationships often extends over hundreds of miles.

During the five-month interval, a Western Australian Native Welfare patrol had contacted them briefly and brought a young man named Yutungka into Warburton to be circumcised. He was accompanied by an elderly man named Tjitjinanya. The group had been isolated for so long that Yutungka was well past the age when men normally are circumcised, and he was anxious to have it done as soon as possible. For many years his group had not met with other groups of Aborigines to form a gathering large enough for the precircumcision ceremonies to take place.

The operation was performed early in April, and we offered to transport the two men back to their



country as soon as Yutungka was well enough to go. We also took with us an elderly Aborigine named Minmara, an intelligent man of outstanding good humor, whom we had come to know well during our previous stay in the desert. We had been with him many times in his own country, about 150 miles northwest of Warburton, and by now he was familiar with the nature of our work. We brought him with us in the hope that, in his own way, he would be able to explain to the others what we were doing. With small, unacculturated groups there is always the danger that the anthropologist's presence will disrupt their activities. We wanted to observe as much as possible of their normal daily routine, but we also wanted to record what we saw with photographs, maps of their camp, tape recordings, and ordinary field notes. Minmara, already familiar with our equipment, could reassure the others.

We outfitted two vehicles for the trip, a Land Rover and a two-wheel drive truck. Because of the distance, supplies were a problem and limited us from the start. We had to be completely self-sufficient. The truck was loaded with drums of fuel and water and we intended to drive it as far into the desert as possible. For two days we drove up a deserted rocket range access road, locally called the "Gunbarrel Highway," to a point about 80 miles from where the Aborigines were said to be camped. Then we refueled the Land Rover and left the truck where it would serve as a gas station for us on our return trip.

During the trip out, Minmara did several things that seemed odd and unlike him. On one occasion he asked me for some cigarettes. Because I want to avoid having to feed the people we are with, I always try to be generous with tobacco instead. For anthropologists, feeding the people is a never-ending problem. If we are to observe their normal food-getting behavior, we cannot always feed them. This leaves us open to accusations of stinginess. On this trip, however, I had brought only plugs of chewing tobacco. Minmara had never before asked me for cigarettes and, in truth, I had never seen him smoke them. Nevertheless, he seemed disappointed when I offered him some chewing-plugs. Later he came to me again and asked for my rifle and one bullet. Minmara had borrowed my rifle many times before to go kangaroo hunting, but he had always asked for as many bullets as he could get. When I asked him why he wanted only one bullet this time, he seemed genuinely at a loss to explain. After I gave him the gun and the single bullet, he walked to the edge of our camp where the other two men could see him, loaded the rifle, and fired it off into the air. Then he returned the gun to me and in a low voice explained that these were ignorant men who did not know about such things. This really floored me, since I could remember when, not so very long ago, Minmara himself had been a desert Aborigine just like these men. He obviously had meant to smoke the cigarettes in front of them as well, to impress them with his newfound sophistication.

We continued our cross-country trip to the west, skirting several sandhills and wide stretches of burned-over country. Yutungka excitedly pointed out places where he himself had set the fires. As we were traveling in a time of drought, the wind was shifting the sand in many burned-over places. At Warburton, less than an inch of rain had fallen in two years, and conditions looked similar here. I was particularly anxious to observe these Aborigines under drought conditions, since our previous trip to the Gibson Desert had been during a period of exceptionally good rains, with a corresponding abundance of plant and animal foods. Eventually we saw Mount Madley—two tiny rock knobs standing about 25 feet above the surrounding sand plain, yet appearing highly significant in comparison with the relatively flat terrain. Claypans and salt lakes provide the few landmarks in this region, which on the whole is among the most featureless and unfriendly looking country we have ever seen in the Australian desert. The spinifex, a spiny grass that grows in clumps of varying size and density throughout the Gibson Desert, appeared parched and yellow. There were some signs of recent rain on several claypans we crossed, but rain in this region is notoriously fickle and often falls only in localized patches. The mulga scrub we passed also looked dry and brittle. On our previous trips in the Gibson Desert, we had

Yutungka's mother huddles with her dogs on an early winter morning at the camp at Pulykara. At right, Yutungka stands halfway down a 15-foot-deep native well.

seen the country at its best; now it seemed we were seeing it at its worst.

Arriving at Pulykara on the morning of April 20, we found that the Aboriginal camp consisted of three small clusters of hearths. each surrounded by cleared patches of sand—the sleeping and sitting areas—and a low brush windbreak. The arrangement was typical of the winter campsites of Gibson Desert Aborigines, which we had observed on previous occasions. Situated on the slope of a sandhill at the edge of a dry lake bed, it was sur-

At the claypan of Walaluka, fifty miles from Pulykara, Yutungkā tests the water, and finds it potable.

rounded by a profusion of flies, an inevitable feature of Aboriginal camps. The wind was blowing fairly hard when we arrived, and it was apparent that there was little natural cover here or anywhere nearby. Burned acacia bushes and a few low clumps of ti tree, spinifex, and saltbush gave the whole place a rather cheerless look. The water hole, a so-called native well dug about 15 feet in the lake bed to the water table, lay about 425 feet southwest of the camp. These native wells are, in most cases, nothing more than soakages into which the Aborigines dig for water. Often they get deeper as the water table retreats downward. Pulykara, a classic example of this type of well, had a flow at that time of about a gallon in ten minutes. We had already been told that Pulykara was one of the most dependable water sources in the region and was virtually permanent.

No one was visible when we arrived at the camp, but on top of the sandhill there were several emaciated, howling dingoes, dogs kept by the Aborigines and sometimes found wild. Yutungka set fire to some ti trees as a smoke signal to indicate our presence, while Tjitjinanya and Minmara went on foot over the sandhill to look for the people. A few minutes later they returned with Tjitjinanya's wife, a tiny woman with a greatly distended stomach. She had heard us approaching—the whine of a Land Rover's gears can be heard for miles—and was frightened, so she ran off into the sandhills to hide. The others, she said, had left earlier to look for food.

This timidity was apparently one reason why this group had not been contacted earlier. Later on, Yu-

tungka told us that when he was a small boy, a truck (probably another Land Rover) had passed this way with one man driving it. Everyone had run into the sandhills and watched the white man from behind some bushes. The vehicle missed the camp by about a quarter of a mile, passing on the far side of a sandhill to the north, where the man had stopped and spent the night before continuing his journey in the morning. The Aborigines stayed awake all that night watching him, but they never revealed themselves. This, no doubt, must have happened many times to government patrols sent out to locate desert Aborigines.

After the others arrived, there were nine people, comprising three small families, present: Yutungka's mother and father, Tjitjinanya and his wife, and finally a third couple and their two daughters—a six-year-old named Pannyi and an infant. While talking with them we quickly discovered several words derived from English, and learned that the young couple had previously spent some time at the Carnegie Homestead, a remote sheep station a little more than 100 miles southwest of Mount Madley. Also, Yutungka's father said he had once spent a few days at Jiggalong, a mission and Aboriginal reserve about 200 miles northwest of Mount Madley. Aside from these instances and Yutungka and Tjitjinanya's recent trip to Warburton, these people had lived all their lives in this area of the desert. As Betsy was the first white woman that most of them had seen, the women could not stop touching her arms and hair and discussing her appearance. Some of them had a few scraps of clothing given them by the preceding patrols, and they possessed a steel axhead. The tenth member of the group, a young man named Yiwa, had gone off to the west by himself to look for some spearwood. We missed seeing him, since he still had not returned when we departed for Warburton. These

While carrying a dog around her waist, Tjitjinanya's wife sympathetically covers its eyes so it will not see her eat a piece of candy.

people spoke a dialect, which they called Ngatjara, one of the many mutually intelligible dialects spoken by Aborigines throughout the Gibson Desert.

Yutungka was clearly delighted to see his parents and other relatives again. They greeted him by wailing loudly, while his mother flailed herself on the head with a wooden bowl until the blood ran freely from her scalp. This was out of sorrow for the pain he had undergone while being initiated at Warburton and in recognition of the death-rebirth symbolism of the whole initiation ceremony. Once these formalities were over, the group settled down to discuss their recent activities and, no doubt, us, while we set up our own camp about 100 yards away. Yutungka kept everyone up late that night with his dramatic and highly animated account of his experiences at Warburton.

The Gibson Desert Aborigines live entirely by hunting and gathering wild foods. They do so in what is probably the poorest environment, in terms of food resources, of any in the world where people have lived by foraging directly off the land. In our earlier studies we found that the Aborigines in this area subsist on 38 edible plant species, called *mirka*, and 47 named varieties of meat and fleshy foods, called *kuka*. *Kuka* is always preferred over *mirka*, but our studies indicated that *mirka* is almost always more important in the over-all diet. As there are no large game animals, the kangaroo, which rarely exceeds 100 pounds, is the largest animal hunted, although they are uncommon in the Gibson Desert. Herds of game animals, such as one finds in Africa today, do not exist in this area. Most of the protein obtained by these people comes primarily from two species of goanna lizard found in the sandhill and sand plain country. With the exception of rare occasions when heavy rains have fallen for two or more consecutive seasons in one spot, providing abundant vegetation and therefore attracting game, the diet is almost entirely vegetarian, revolving around at least seven staple plant foods. I have defined a staple here as any plant species that, singly or in combination with another, accounted for at least 50 percent of the total diet by weight during the period it was collected and consumed. Other edible plants act to supplement and vary the diet. Although men hunt regularly for kangaroos, emus, wallabies, and other game, it is the women who are the mainstay of the economy and who provide virtually all of the vegetable foods, as well as much of the small game.

Compared with other hunting-and-gathering societies, the Gibson Desert Aborigines fare poorly even in the best of seasons. For example, the !Kung Bushmen of the Kalahari Desert of Africa, a group recently studied in detail by anthropologist Richard Lee, distinguish 54 edible species of animals (including some, such as giraffes and various antelopes, that are larger than anything found in the Australian desert) and 85 edible plant species, one of which, the mongongo nut, accounts for one-half to two-thirds of the total vegetable diet by weight. The Bushmen, therefore, can afford to pass up such small game as rodents, snakes, lizards, termites and other insects, all of which are eagerly sought by the desert Aborigines.

Any anthropological discussions about the material culture, social organization, and religion of the desert Aborigines must be seen in terms of the basic ecological considerations. Not only is the Gibson Desert generally impoverished in edible plant and animal species, it is also unreliable in terms of the ripening and availability of these species. There are no regular wet and dry seasons, such as one finds in the Kalahari or even in tropical Australia. Rainfall, generally low to begin with, fluctuates tremendously with time and place. The table shown here for vegetable staples for 1966–67 represents a foraging season under optimum conditions of rainfall for this region: a kind of Aboriginal woman's "shopping list" at a time when there was plenty of rain to stimulate plant growth. The table for 1969–70, although complete for only eight months, shows the plants collected by these same people as staples during a drought year.

It was with this general background of information in mind that we began our visit with the desert Aborigines at Pulykara. On the day we arrived, Yutungka's mother appeared carrying a wooden bowl containing ten grubs and a piece of backbone from a feral cat, which she had evidently taken with her as a snack to eat while out looking for grubs. The young woman, named Yatungka, arrived in camp shortly afterward with a wooden bowl filled with about ten pounds of sun-dried quandong, a native fruit with a large kernel, of which only the outer husk is eaten. I was immediately interested, because neither woman had been out collecting for more than a couple of hours that day. Also, the people seemed in good condition. Things might be hard at Pulykara during the drought, but certainly no one was starving or even close to it.

In the days that followed we settled into a routine of steady, low-key observation as the Aborigines went about their daily affairs. On most days I went out hunting with Yutungka and one or more of the other men, while Betsy either stayed in camp or went foraging with the women. Although we traveled as much as ten to fifteen miles a day in search of game, the results of the hunt were poor. At no time did we see any fresh kangaroo or emu tracks and, after four days of effort we had obtained only a feral cat, a falcon, and three rather small goannas. For me these hunting trips were useful, more for the opportunity of learning about the country around Pulykara and getting to know the men better, than for the game we caught.

Foraging, on the other hand, was more successful. There was an extensive area of quandong trees located about two miles from camp on the other side of the dry lake. Here it was possible to collect almost unlimited amounts of the sun-dried fruit from the ground directly beneath each tree. As long as the weather is dry, this fruit, which the Aborigines call *tjawili,* can lie on the ground for months without spoiling. A woman, working for about an hour, could collect between ten and twenty pounds, depending on the size of her wooden bowl. Not only was the *tjawili* abundant and easy to collect, but on this occasion it was easy to transport, as well, because the walk across the lake bed was fairly short and flat. Grubs, although hardly a staple at this time, were larger and more abundant than we had ever seen in our previous travels through the desert. Pried from the roots of small acacia bushes and from the stems of desert poplar trees that were dying from the drought, they are prized for their flavor by the Aborigines and are eaten either raw or lightly roasted. What impressed me most, however, was the ease and relative speed with which the women found enough food for the whole group, even under what seemed, superficially, to be adverse conditions. It was neither gourmet eating nor a balanced diet, but it was enough; and it took only a few man-hours to collect. So much for the commonly held view of hunter-gatherers as people without any leisure time because of their constant need to search for food. Under the conditions at Pulykara, the women spent most of their day in camp sleeping or talking among themselves. Their foraging was so efficient that it gave them abundant time to relax, while at the same time it freed the men for hunting and other activities. It also became obvious that the group could never have survived on the fruits of hunting alone, although no opportunities for getting game were overlooked.

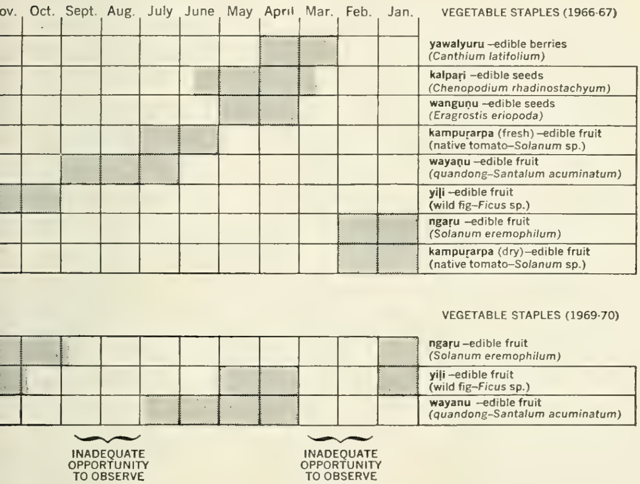
Another glance at the tables will reveal several essential differences between foraging in a relatively wet season and foraging in a drought. While the drought reduced the available species of staple food plants from seven to three, the overall amounts of food collected and the work required to collect them remained about the same. (Despite the incompleteness of our observations in 1969–70, there is good evidence to suggest that there were no more than three staples that year.) That is, in both wet and dry years large quantities of these staples can be collected by the women without consuming too much time or effort in the process. Of course, our observations at Pulykara were brief, but these were augmented by further studies made with similar groups closer to the Warburton Ranges Mission. It is also important to note that the periods of availability of the same plant species vary greatly from one year to the next. *Ngaṛu,* for example, appears to ripen earlier and last longer in dry seasons than in wet years, while *yiḷi,* "wild figs," and *tjawili* ripen at almost opposite times in a dry year from one that is wet. In addition, these food resources can vary dramatically from place to place. No wild figs were available in the Pulykara area during our visit in April, but they were abundant at that time in areas closer to Warburton.

Each morning when the men and I set out to hunt, some of the camp dogs tried to follow us. The men would constantly turn and drive them back toward camp, since they did not want them along on the hunt. Under traditional nomadic conditions, dingoes are a liability on hunts, as they tend to frighten game. These Aborigines hunt mainly from concealment, that is, from

Yutungka cleans the feathers from a falcon killed during a hunt. Hunting, however, provided only a small part of the group's food.

behind blinds of brush or rock or, sometimes, by careful stalking when an animal is encountered in the open. In either case, dogs are not wanted. Nevertheless, I noticed that Yutungka's favorite dog, Pitji-pitji, would continue with us, lurking cautiously about a quarter of a mile behind us or off to one side. Its presence was tolerated as long as it did not get too close to us or otherwise interfere with the hunt.

We counted nineteen dingoes in and around the camp, all of whom would join in piercing choruses of howling in the morning or at night. They were often fondled but rarely fed, although the people expressed sympathy for their hunger. Once, after I had given a piece of candy to Tjitjinanya's wife, she covered the eyes of the dog she was carrying. When I asked about this, she said the dog was *ngaltutjara*, "the one to feel sorry for," because it could not have the food, so she was covering its eyes in the hope that it would not see her eating.



ov.	Oct.	Sept.	Aug.	July	June	May	April	Mar.	Feb.	Jan.	VEGETABLE STAPLES (1966-67)
							▨	▨			**yawalyuru** –edible berries *(Canthium latifolium)*
					▨	▨	▨	▨			**kalpaṛi** –edible seeds *(Chenopodium rhadinostachyum)*
						▨	▨				**wanguṇu** –edible seeds *(Eragrostis eriopoda)*
				▨	▨						**kampuṛarpa** (fresh) –edible fruit (native tomato–*Solanum* sp.)
		▨	▨	▨							**wayaṇu** –edible fruit *(quandong–Santalum acuminatum)*
▨	▨										**yiḷi** –edible fruit (wild fig–*Ficus* sp.)
									▨	▨	**ngaṛu** –edible fruit *(Solanum eremophilum)*
									▨	▨	**kampuṛarpa** (dry)–edible fruit (native tomato–*Solanum* sp.)

ov.	Oct.	Sept.	Aug.	July	June	May	April	Mar.	Feb.	Jan.	VEGETABLE STAPLES (1969-70)
▨	▨									▨	**ngaṛu** –edible fruit *(Solanum eremophilum)*
▨						▨	▨			▨	**yiḷi** –edible fruit (wild fig–*Ficus* sp.)
				▨	▨	▨	▨				**wayanu** –edible fruit *(quandong–Santalum acuminatum)*

INADEQUATE OPPORTUNITY TO OBSERVE
INADEQUATE OPPORTUNITY TO OBSERVE

Not only were these the skinniest dogs I have ever seen, but they were also compulsive cringers and skulkers. Throughout our stay we had to be on guard against their getting into our belongings, since we found that they will eat almost anything. Despite our efforts, one of them consumed the electric plug and three feet of heavy-duty electric wiring from our portable generator. On past occasions dingoes have devoured boots, entire boxes of detergent, and magazines; occasionally, they have even pierced tin cans with their teeth and extracted the contents with their incredibly prehensile tongues. One glance and a hissing shout of *payi* was always enough to drive them away for a while, but it was a never-ending battle in which the dingoes' perseverance inevitably won out.

Most Aborigines, both men and women, have their favorite dogs, but we noticed from the start that Yutungka's mother behaved very strangely toward her dogs. She carried this behavior to a fanatical extreme, and we christened her the "Dog Lady" because of it. She cared for about a dozen dogs, which formed a seething pack around her whenever she was seated in her camp. She seldom fed them but fussed over them constantly in other ways. When they were asleep she built little shade-shelters of twigs and boughs for them, which she moved periodically as the sun's shadow shifted, being careful all the while not to disturb the sleeping dogs. Like most of the others, she was naked when we met her on the first day, but Tjitjinanya had given her some tattered dresses and other clothing he had acquired during his brief stay at Warburton. Instead of wearing these herself she laid them over the dogs while they slept during the day. At this time the days were warm, about 80 degrees Fahrenheit in the shade, but at night it was close to freezing. On chilly nights the desert Aborigines always sleep next to a fire with their dogs huddled around them to keep warm; Yutungka's mother, of course, had most of the pack wrapped around her. One night I tried taking flash photographs showing how the people sleep with their dogs. No one minded the picture-taking except the dogs: I had not reckoned on their reaction to the flash. After my first photograph, they ran off into the sandhills while the people lay shivering by their little fires, bereft of their doggy "blankets." I apologized, but it was a while before the dogs came back.

The Gibson Desert Aborigines are among the last people anywhere who still make and use stone tools as a regular part of their culture. On our previous trips into the desert we learned that these people possess a limited variety of stone tools used for cutting meat and sin-

ew, as well as for scraping or adzing wooden tools (*see* NATURAL HISTORY, February, 1968). They classify these tools as *tjimari* and *purpunpa*, respectively. For archeologists in particular this is useful information, since they are concerned much of the time with the ways in which ancient stone artifacts were made and used. Since this activity rapidly declines once the Aborigines obtain metal tools, we were fortunate to see as much of this skill in action as we did. But there were still some unanswered questions; the most important of these was the role of hand axes and hand-held stone scrapers.

All of the groups we had previously observed had already obtained enough steel axes for their needs. Aboriginal stone axes had been seen in use by earlier scholars such as anthropologists Norman Tindale and Donald Thomson, but their classification within the native system remained uncertain, along with other details concerning their manufacture and use. As I had hoped for some time to find a group of desert Aborigines who had not yet transferred to the use of steel axes, the group at Pulykara proved ideal. The single steel ax they possessed was not sufficient for their needs as its large size made it awkward to handle and limited its usefulness; therefore, they continued to make and use large, hand-held stone tools along with other kinds.

The people at Pulykara classified all hand-held scrapers and hand axes as *purpunpa*, regardless of size. Always trimmed on one edge only, they were used exclusively for cutting and shaping wooden objects. In general, hand axes and large stone scrapers were trimmed by chipping just enough to provide a steep working edge suitable for woodworking. These observations are of particular interest to Australian archeologists, since recently accumulated evidence points to the persistence of a hand-held, stone flake tool tradition in some parts of Australia for over 30,000 years. Although various hafted stone tools, some of them quite delicately made, appeared at least 6,800 years ago in the Gibson Desert, they never displaced the tradition of making large, hand-held tools. Further analysis of the tools will be needed before this pattern can be described in detail, but preliminary studies indicate that we are dealing here with one of the most dramatic and well-documented examples of cultural conservatism in the world.

By our fifth day at Pulykara our supplies were dwindling and it was obvious that we had to leave before we consumed our reserves. In the Australian desert one always keeps enough extra food and water for a possible breakdown or emergency en route. The evening before we left there was an intense discussion in camp. Tjitjinanya wanted to return to Warburton with us—he craved the excitement of other people. The women countered him, saying they liked the things he had brought for them from the mission but they wanted him to remain at Pulykara with them. The argument went on late into the night, and in the end Tjitjinanya agreed to stay. Betsy and I did not interfere, but we both knew that it was far better at that time for Tjitjinanya and his wife to stay in the desert. For one thing, the two older men at Pulykara address Tjitjinanya as *kamuṛu* and regard him as a mother's brother—an obligatory sharing relationship in which most of the goods and services flow from the sister's son to the mother's brother. Tjitjinanya and his wife have no children of their own, and since they are both getting old and one of them is infirm much of the time, they must consider who will support them in their old age. Even under the harsh conditions of desert existence, the Gibson Desert Aborigines do feed and look after old or sick people—but only if a sharing relationship based on kin ties exists between the people involved. Tjitjinanya and his wife had no close kin at Warburton and might suffer privation there. On the other hand, because of Tjitjinanya's *kamuṛu* relationship to the oldest man in each of the other families at Pulykara, they had, in effect, two families working for them, gathering food, firewood, and other necessities. It was undoubtedly wiser for them to remain at Pulykara, and I was relieved when the ladies finally won out. We left for Warburton the next morning, accompanied by Minmara, while the others remained at Pulykara.

What had we achieved by making this trip? Certainly we made no startling or fantastic discoveries; we found no "vanished tribes." Essentially, these people at Pulykara were like those we had encountered in our earlier work in the Gibson Desert. Although they live in a poor and undependable physical environment, they have survived and developed rich oral traditions and ceremonies along with a social system of amazing subtlety and complexity. Further research must inquire into how these systems are supported by the economy and how, in turn, they serve to maintain the economy. Our trip to Pulykara offered us another glimpse of the day-to-day economy of a nomadic group of Aborigines, and increased our understanding of how these people have adapted to their desert existence. However, there still are things we do not know. For example, how do people like this support themselves in a drought of ten or twelve years duration?

Like many anthropological expeditions, we obtained scientifically useful results without undue hardship or excessive fanfare. And from a personal point of view, there was something esthetically satisfying about this trip. We met these people on their own terms, in their own country. It was indeed a pleasant change from meeting Aborigines, as we have so often, living on the fringes of white settlements where they are increasingly dependent on the white man's culture. The friendliness, independence, and pride of this small community provided a rare and rewarding experience.

After several hours in the bush, Yatungka and her daughter Pannyi return with about ten pounds of sun-dried quandong.

GOOSE OF THE HIMALAYAS

Bar-headed geese
migrated between India
and Tibet
before the Himalayas
rose up 30,000 feet.
Mountains or not,
they still ply
the same route,
honking as they fly
at altitudes where
they should not
be able to breathe

by Lawrence W. Swan

At night there is a quietness in the high mountains. Far into the Himalayas, among the glaciers and the walls of great peaks, a stillness settles, and when the wind is gone and the torrents are frozen, there is no background of singing crickets or airplanes or distant voices. The quiet is different from that of a closed room, for against the stars the dim outlines of crests and ridges show the vastness of the space—and it is all soundless. It is as if the whole world had ceased. One seems to hear the very absence of sound. Then the roar of an avalanche or a rockfall booms across the valley, sudden and brief and then gone, echoing its way down the canyons into silence again.

On one such cold and still night in early April, I stood beside the Barun Glacier. At 16,000 feet, above nearly one-half of the atmosphere, the stars were brighter; and old, familiar constellations acquired new, small bits of light unseen at lower elevations. Even without a moon the peaks could still be seen, and the great dark cliffs of Makalu rising more than two miles above me to the northeast were outlined by a halo of starry brightness. Mount Everest some miles up the glacier to the northwest, Chamlang to the southwest, and Tutse to the south encircled my spot on the moraine in a dark ring against a lighted sky. I was listening to the silence. And then a sound came, a quiet hum muffled by distance. But this sound had a pitch, an alien quality in a land where sound is generally a clatter or a roar or a hiss. It grew louder, and suddenly I knew. I had heard it before. Coming from the south, the distant hum became a call. Then, as if from the stars above me, I heard the honking of bar-headed geese.

I searched for their outlines in the darkness, hoping to see a spot of light go off and on as their wings passed a star, but they were too far above me. I know that it is possible to locate an object by sound within a very few degrees of its actual po-

After mating, a male bar-headed goose spreads its wings widely over the female—a common sight on the spring breeding grounds.

sition and confident of this ability, I listened and followed them across the sky. Their calls diminished, and finally, somewhere beyond the Barun-Kangshung Divide over Tibet, their sound ceased. I realized then that I had followed their movement directly over the summit of Makalu, 27,824 feet high.

Later I learned that climbers had seen geese fly over the summit of Mount Everest, 29,028 feet above sea level, but that night beside the Barun Glacier I felt I had witnessed the most incredible feat of bird flight. At 16,000 feet, where I breathed heavily with every exertion and where talking while walking is seldom successful, I had witnessed birds flying more than two miles above me, where the oxygen tension is incapable of sustaining human life—and they were calling. It was as if they were ignoring the normal rules of physiology and defying the impossibility of respiration at that height by wasting their breath with honking conversation.

Thinking about the wonder of this accomplishment, three questions posed themselves. First, because it seemed so strange from my own high-altitude experience, I wondered why the geese were not silent, thereby conserving oxygen. Second, of all the places to fly across the Himalayas, why should they pick the highest spots to cross? A few miles to the east, the

Arun Gorge reaches Tibet at less than 10,000 feet and this passage to the 14,000-foot plateau would seem much easier to negotiate. Third, why should these geese, which spend the winter months in the warm waters of the Indian plains, fly to Tibet where most of the lakes are barren, salty wastes and where greenery itself is an exception? Why should they make such a seemingly poor choice and in doing so have to cross the greatest mountain barrier in the world?

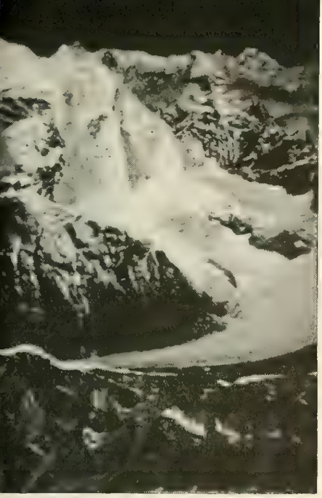
I think I may have a few answers: some obvious, others speculative. A study of the migration of the bar-headed goose *(Anser indicus)* provides much information about the history of Central Asia. It touches on the geology of mountains and tells us in rather vivid terms of the changes in the past.

A look at the map of Tibet shows a desert raised up to 14,000 feet or more, where dryness is augmented by bitter cold. The severity of the environment can scarcely be matched. For the most part its hills are barren and its valleys waterless. Nevertheless, Tibet has many lakes and it is these lakes—their positions and shapes—that are perhaps most revealing in the story of the geese. In the west the tributaries of the Indus reach into Tibet, and beyond the present limits of these rivers a series of lakes can be seen. They are generally at the same altitude along a continuous basin, and some of them reveal in their shape a long, sinuous outline as if a river valley had been filled with water. Throughout Tibet lines of connected lakes tell the story of old river valleys that somehow became dammed and separated from the main stream. It is difficult to dam a river. To the south, where the Arun and other rivers cut tremendous gorges right through the Himalayas, it is clear that the stream preceded the mountain uplift. The huge mass of the mountains rising athwart the rivers was not able to dam them. The reason lies in the amount of water carried by the stream. If the river is running full, it generally cuts down just about as fast as the mountains can build and it will not be stopped.

Geologic observations indicate that the old Tibetan rivers flowed eastward from western Tibet, the highest part of the Tibetan plateau. Today this is a vast deserted land lying mostly above 18,000 feet. The area of the plateau lying between elevated western Tibet and the modern sources of the Yangtze, Mekong, and Salween rivers far to the east, is a land of lakes. The Tsangpo River is the only remnant of the old river system that today flows entirely across Tibet from west to east, but its course has been rudely interrupted and captured by an active tributary of the Brahmaputra River, the Dihang, which has cut its way directly through the Himalayas of Assam. The Tsangpo now flows through a huge gorge into India as the major tributary of the Brahmaputra but, in all likelihood, it was once one of several main tributaries of the Salween. Perhaps the Tsangpo remains as a relic of this old river system because it gets some water from the nearby snow-capped Himalayas, whereas the old tributaries of the Yangtze, Mekong, and Salween farther north were not able to cut and prevent their occlusion by the uplifted land of Tibet. Without sufficient water, they degenerated into strings of lakes with no outlet to the sea. The sources of the modern rivers now lie far away on the eastern slope of the Tibetan plateau where some moisture reaches up from China and Southeast Asia. How did the old Tibetan rivers lose most of their water and the fullness of flow that kept them active?

Precipitation in Tibet is generally less than 10 inches per year. The moisture that settles as snow on the highest peaks is a mere wisp of the monsoon. The snowmelt keeps some of the lakes fresh and also supplies the flow to the Tsangpo, which ultimately becomes the great Brahmaputra of India. South of the Himalayas, places like Cherrapunji may get 900 inches of rain annually. In 1861 a world record of 1,041 inches fell on this town in the Khasi Hills of Assam. Rainfall of more than 100 inches is commonplace on the southern slopes of the Himalayas. The monsoon reaches up the valleys and in those few gorges that traverse the range some clouds carry through and reach up to Tibet. Most of the range exceeds 20,000 feet, and little effective moisture crosses this huge barrier directly into Tibet. The dry hills of Tibet are a result of the Himalayan range, which reaches up through most of the atmosphere and effectively throws a rain shadow across Central Asia. Because the now dead rivers of Tibet did at one time flow, the Himalayas could not have always been the barrier they are today.

Recent research reveals the suddenness, in geologic time, of the final upthrusts of the Himalayas. The beginnings of the range date back ten to fifteen million years into the early Miocene Epoch, but for most of the time since then, the Hima-



Migrating bar-headed geese fly over such imposing obstacles as Mount Baruntse (23,688 feet), in Nepal.

layas were insignificant and did not materially impede the movement of moist air from the south. It was only in the late Pliocene and early Pleistocene, perhaps a million years ago, that the Tibetan plateau was uplifted to nearly its present height. This was followed in turn by the final upthrust of the highest Himalayan peaks, which must have risen 10,000 feet or more in the space of a few hundred thousand years. This last spectacular upheaval of the earth was essentially completed less than half a million years ago, and with it the climate of Central Asia must have turned from humid to arid. The rivers that were already cutting their valleys into the elevated land of Tibet ceased. Lakes formed in the river beds and, as with the desert lakes of the American West that were left after the glaciers retreated, they shrank by evaporation, concentrating their supplies of dissolved minerals. The salt lakes began, and to the accompaniment of the cold and warm phases of the Pleistocene, the environment of Tibet became a desert.

Into this picture came the bar-headed goose. When it first arrived in India is only a guess, but as the behavior of most migrating birds suggests, these geese responded to the glacial expansions and retreats of the Pleistocene glaciers, and their presence in Central Asia probably predates the beginnings of glaciation during the Pleistocene. At that time—presumably during the late Pliocene Epoch—it is likely that parts of Tibet had lush green valleys with lakes and streams in summer. The flight between India and the north was a simple adventure—from winter feeding grounds to a congenial breeding summer in the moist valleys of Tibet. Then the earth started to move and the Himalayas reached for the sky. Year after year the birds flew their annual circuit and as the thousands of years went by, the mountains rose beneath them. Higher and higher they drove the geese, which in turn met the challenge. Surely a mountain range reaching that high through the atmosphere into the frigid lower limits of the stratosphere would defeat the flight of birds? No—the birds beat the mountains. Each year they accomplish the incredible: in one majestic flight to the north in March or April and a similar return in September or October, they span the highest ramparts of the earth. Their flight, like a behavioral fossil, tells of a time when the Himalayas were small and the rivers flowed full in Tibet. The geese over Makalu are older than the hills below them.

The challenge of the Himalayan altitudes was accompanied by the forbidding threat to survival posed by the drying up of Tibet. In place of a multitude of wet marshes, ponds, and streams, the habitats of the geese dwindled to a few hostile valleys. The birds now congregate along the Tsangpo River, and here and there on the freshwater lakes. They are wary and elusive on the northern plains in India where they are hunted throughout the winter. From the few accounts of travelers who have encountered them in Tibet, it seems the geese are crowded and careless of their safety. I have heard that in places they are so tame, they can be clubbed. At any rate, these concentrated flocks among the rocks and arid slopes surrounding unproductive ponds are a far cry from the birds of India. But even this great change has not been enough to destroy them. It may be of significance that until recently the Tibetans were Buddhists, who generally protected life or at least did not wantonly destroy living things. Sven Hedin remarks in his great work *Transhimalaya* that Tibetans considered bar-headed geese to be particularly favored for protection inasmuch as the birds mated for life and the killing of one bird left the other in a state of humanlike remorse. Killing geese, as he learned from the objections of Tibetan hunters, was in a different moral category from killing sheep or pheasants. Perhaps the geese, in their tameness and their protected status in the vicinity of monasteries and religious preserves, owe something of their survival to a considerate human population in the past. Whether this situation changes remains to be seen. Recent political and economic instabilities, and the presence of armed Indian and Chinese troops, are not conducive to the survival of edible wildlife. It would be instructive to get information on the population status of the bar-headed goose as it returns each year from Tibet. It seems to be declining. It may be that after all the victories over mountains and climate and time, the bird will be defeated by man's callousness and its demise related in some way to the demise of Buddhism itself in Tibet.

Next there is the question of why the birds fly over the highest peaks and apparently avoid the several gorges that penetrate the Himalayas at lower altitudes. Perhaps some of them do fly at lower altitudes, but I have not heard them in the gorges. I have heard them far above Darjeeling headed directly toward the great massif of Kangchenjunga, and other reports of their presence coincide with the main mountain barriers along the eastern Himalayas.

The air over India before the monsoon is probably the dustiest in the world. Distant views are out of the question. But as an airplane rises out of the murky air of Bihar or Bengal the form of the Himalayas emerges to the north. From 200 or 300 miles away the great range is not a continuous line but can be seen only as patches of white snow scattered and separated across the northern horizon. These are the great groupings of peaks divided by lower mountains and the deep river trenches of the range. The Kangchenjunga group is discernible in far-off northern Sikkim; nearly 70 miles to the west the Everest-Makalu group stands out, and beyond that, the Rolwaling summits, then the Ganesh Himal, the Annapurna chain, and Dhaulagiri. The human observer sees the highest points, visible at enormous distances from the south. Couldn't this also be the case with the geese? The great Himalayan upthrusts can be identified and located, whereas the gorges and passes would be difficult to find and follow. Furthermore, most flights reach the mountains during the night when flying between the peaks and cliffs could be precarious.

In the matter of safety there is also the consideration of wind. In spring the Himalayan traveler is sometimes able to see the great peaks displaying long plumes that reach out from the mountains for several miles. These long, steady, bannerlike clouds are not typical. They may be likened to the contrails of jet airplanes and are undoubtedly caused by enormous winds. I know of no accurate analysis of this type of cloud. It is obviously not composed of windblown snow over its full length of several miles, although in the vicinity of the peak, as the flight over Mount Everest in 1933 demonstrated, there is a violent hail of ice particles. It would appear that on its lee side the sharp summit of a mountain in a high wind produces a sufficient air pressure decrement to initiate condensation, which in turn must freeze into minute ice particles that remain suspended in the air as a long and stable cloud. Typically these banners affect only the highest peaks and from Sandakphu, near Darjeeling, I have seen a trio of plumes extending from Everest, Makalu, and Kangchenjunga at the same time. It is possible that these three great peaks, all over 27,000 feet, are high enough so that their summits are occasionally swept by a low jet stream of the stratosphere, with air moving at more than 200 miles per hour. I have seen a plume from fairly close on Makalu. Whereas the air below was still, the summit pyramid was boiling with white spumes of clouds, and down the ridges from the summit, twisting vortices of snow, like miniature tornadoes, gave evidence of the power of the air. Even though the peak was a mile or more away, the whole mountain seemed to moan. The roaring wind on the mountain top covered the valley below with a low, steady sound like the deep tones of an organ.

Consider a bird flying into this maelstrom. Unless it could fly higher than the highest peak, it would be hurled into a mountain. Flying high, it might be driven hundreds of miles out of its course, but it could survive.

Incidentally, as far as I know, no carcasses of bar-headed geese have been found in the high snowfields of the Himalayas. Georges Blond in his book *The Great Migrations* writes poetically of greylag geese being driven by winds into the snow slopes of Mount Everest, but I cannot find any actual reports of such an event.

There are other geese in India, notably the greylag goose (*Anser anser*) and the white-fronted goose (*A. albifrons*). These, together with a few rare species more typical of other parts of Asia, must also cross parts of Central Asia to get to their summer breeding grounds in Siberia. The greylag goose is known to cross high mountains. Indeed, in order to fly from western Siberia to Kashmir and northwestern India it must cross, depending on its destination, the Tien Shan Range, the Takla Makan Desert, the high barrier of the Kunlun Range, the Tibetan plateau and the far western Himalayas. Some of these geese must surely fly over the Karakoram and Pamir barriers. There is a report, which I have been unable to authenticate, of an airplane sighting of these geese flying at 26,000 feet.

Another report involves a flight of geese over the western Himalayas. The geese, probably either greylag or bar-headed, were seen through a telescope as they passed in front of a full moon. Their altitude was estimated at 29,500 feet, but because it was impossible to use triangulation, the figure is subject to doubt. For the most part, however, the specific routes of these trans-Tibetan migrating geese are not known. Apparently, they do not fly over the eastern Himalayas. The migration patterns of some birds suggest that geese other than the bar-headed goose move first to northwestern India and Kashmir and then cross the mountains to the north.

It seems that many smaller birds follow the routes of river trenches such as the Indus and Sutlej in the west and the Arun and Brahmaputra in the east; however, migrant birds of many species are found deep in the Himalayas making their way across the high passes but staying close to the ground. Wollaston, during the 1921 reconnaissance of Mount Everest, recorded among migrants Temminck's stint (*Calidris temminckii*), pintail snipe (*Gallinago stenura*), house martin (*Delichon urbica*), Blyth's pipit (*Anthus godlewskii*), Hodgson's pipit (*A. roseatus*), and several other migrants from the plains of India at altitudes above 17,000 feet beside the glaciers on the Tibetan side of the Himalayan Range. He also records a hoopoe (*Upupa epops*) from 21,000 feet flying over the Kharta Glacier. This is a few miles directly north of the Barun Glacier, where at 19,000 feet I met a hoopoe going up while I was coming down.

Both of us were walking. In the barren waste of the glacier this bird of the warm plains seemed unreal, and the power of the drive to migrate was dramatically portrayed in its steady gait as it hopped over the boulders and went doggedly on up toward the 20,000-foot pass at the head of the glacier. It must have covered a quarter of a mile while I watched. (Fortunately, Wollaston's observation of a hoopoe in flight dispels the uncomfortable and improbable possibility that this bird walks all the way to Tibet.) There may be more than 30 species of birds that regularly migrate across the high passes of the Himalayas.

The bar-headed goose, the only one known to migrate over the eastern Himalayas and the only goose known from the lakes and rivers of southern Tibet, is accompanied in its high habitats on the plateau by several other species of Indian-wintering wildfowl. These include ruddy sheldrakes (*Tadorna ferruginea*), common teals (*Anas crecca*), pintails (*A. acuta*), gadwalls (*A. strepera*), wigeon (*A. penelope*), and several other water birds. These birds undoubtedly migrate across the Himalayas, but it is not known whether they fly over the peaks, keep to the passes, or follow the gorges. I have seen teal resting in a small glacial pond at 18,000 feet on the south side of the range, and the pintail has been seen on the Khumbu Glacier at 16,000 feet. This clearly suggests that these birds do not fly directly over the summit of the peaks. Elsewhere in the world, birds flying at 20,000 feet have been seen on radar screens. Perhaps radar studies in the Himalayas would yield information concerning the flights of birds over this highest of mountain barriers.

Lastly there is the question of why the geese keep honking while flying in high, oxygen-deficient air. Unfortunately, most extensive studies on acclimatization and the physiological responses of animals to high altitudes have been conducted almost entirely upon mammals. Invertebrates and the lower exothermic vertebrates seem little affected by low pressures and oxygen tensions. To these creatures high mountains are primarily inhospitable because of low temperatures. Endothermic birds and mammals require more oxygen for survival; but it seems the physiological adaptations of birds to high altitudes has been a neglected field. It has been found that birds with high-altitude habitats have larger hearts, and laboratory pigeons have been shown to increase their red blood cell quantity in response to lowered oxygen levels, but most other knowledge seems to be inferred from mammalian physiology.

However, the respiratory system of sea-level birds has been studied and something can be said about their ability to breathe. Birds do not have the diaphragm and movable rib cage that allow air to enter the chest cavity of mammals. In fact, their lungs are fixed to the ribs and are scarcely inflatable. They have, instead, a series of air sacs. Air passes through the lungs to these air sacs, then passes back through the lungs to the outside. In flight the powerful movement of the wing muscles creates a pumping device that empties and fills the air sacs and passes the air repeatedly through the lungs. A mammal must breathe with special musculature reserved for respiration, and since it has an in-and-out type of breathing, residual, oxygen-deficient air must remain in the trachea and bronchi. Birds, however, fly and breathe with the same muscles and, since the air passes entirely through their lungs, this organ does not hold a component of residual air. The breathing of a bird is essentially more efficient than that of a mammal. Conceivably, at high altitudes in thin air where flight may require a faster wingbeat, the respiration may be accordingly enhanced.

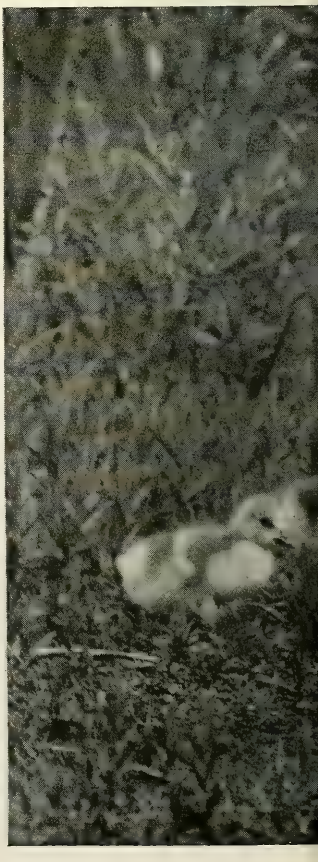
Mammals such as yaks, pikas, wolves, foxes, and sheep wander above 20,000 feet to an approximate maximum of about 21,500 feet in the Himalayas, and acclimatized man with incredible perseverance has reached over 28,000 feet on Mount Everest without the use of oxygen apparatus. The early climbers on Mount Everest who were able to achieve this physiological milestone were visited by scavenging alpine choughs (*Pyrrhocorax graculus*) that wandered regularly up to the 27,000-foot camps, always on the lookout for human waste. These birds, together with the red-billed chough (*P. pyrrhocorax*) and the Tibetan raven (*Corvus corax tibetanus*) are known to follow man and his beasts and any wandering wild mammal wherever they go. The alpine chough was seen by Sir Edmund Hillary on his way to the summit of Mount Everest at 28,000 feet, and I believe it likely that the little cache of biscuits and candy placed on the summit by Tensing Norkay in May, 1953, was visited by alpine choughs on their patrols in search of human debris.

Lammergeyers (*Gypaetus barbatus*), huge vultures of the Himalayas, have been seen flying at 25,000 feet; an eagle carcass was found on the South Col of Mount Everest at 26,000 feet: and a flock of small birds, probably mountain finches, have been seen to fly over this same gap. I have seen a Himalayan griffon vulture (*Gyps himalayensis*) flying at the limit of vision directly above me, a mere speck in the blue sky, while I lay on my back in the sun at 18,000 feet. Through binoculars it seemed unbelievably high, and it flew far above the 22,000-foot peaks of the Rolwaling that surrounded me. Since it is possible to distinguish a moving man at two miles, I believe the six- to eight-foot bird may have been flying at over 28,000 feet. All these records indicate that birds are more independent of altitude as a limiting factor than are mammals, and that it is their food supply and nesting opportunities that restrict their actual residency to lower altitudes. In this regard, alpine choughs have been seen nesting at 21,500 feet, and I have found the nest and eggs of a snowcock (*Tetraogallus tibetanus*) at nearly 19,000 feet. It should be noted, however, that the bar-headed geese begin their northward flight at nearly sea level and may reach an altitude approaching 30,000 feet in the same day, allowing no time for acclimatization. This it seems would be a challenge to any type of respiratory system. I think it is incredible. Perhaps there are preparatory changes in their hemoglobin and vascular system prior to their flight, but this would seem even more incredible.

The sound-making apparatus of birds is the syrinx, located where the bronchi join the trachea. It does not function exactly like the mammalian larynx. The syrinx is related to the unique respiratory system of birds. The call of some birds in flight may last through several wingbeats and a continuous expiration would be necessary for this to occur. This would presumably interfere with regular breathing. If the sounds of geese are made to synchronize with wingbeats, and this does not seem to be the case, then their calling should not require any alteration of their breathing rhythm or a deficiency in their oxygen supply. It would be similar to a man who merely grunts upon expiration when he breathes. Talking or longer sounds require control of the diaphragm and cessation of the breathing rhythm. Perhaps birds have evolved some method of sound production that does not interfere with breathing rhythm or has little effect upon a regular oxygen supply but, as far as I know, this speculation, which derives from the sound of birds high above Makalu, is unanswered.

Nevertheless, why should geese keep honking while flying in oxygen-deficient air? It has been suggested that they communicate with each other. From older studies and from more recent computerized calculations, the V-shaped formation of flying geese appears to be of aerodynamic importance: if it is properly positioned, each bird gets some lift from the wingbeats of its neighbors. Conceivably, the calls of geese enable the birds to better appraise the shape of the flight and allow for distinct positions to be maintained. This may be true, but I see another function. My answer is speculative, but nevertheless intriguing.

It is well known that some birds that live in dark caves, such as the oilbirds (*Steatornis caripensis*) and some swiftlets of the genus *Collocalia*, use echolocation, but the use of sonar by night-migrating birds is apparently unreported. The presence of an echolocating ability in a variety of nocturnal mammals other than bats and tenrecs seems a justifiable assumption inasmuch as it has been demonstrated that man himself, an almost strictly diurnal mammal, can locate relatively small objects by hearing echoes from his voice. The ears of birds, although lacking the three ossicles of the middle ear of mammals, seem to function as well with a single bone. Most birds are diurnal and would not use echolocation as a substitute for eyes, but many nocturnal birds are also prominent sound-makers. The shrill calls and flight behavior of nighthawks (*Chordeiles*) and related birds, and their ability to catch flying insects in twilight and near-darkness, suggest an echolocating ability reminiscent of bats. This would be a fine subject for research. There are other examples of bird behavior that could be investigated for information concerning echolocation. I am impressed by the clicking sounds made by my pet great horned owl (*Bubo virginianus pacificus*) when it is surprised in darkness. The sound greatly resembles the noises made by echolocating cave birds. These clicking sounds are also made by the night-flying swallow-tailed gull (*Creagrus furcatus*) of the Galápagos Islands. When they are disturbed at night in my aviary, the peculiar hovering flight of orange weaverbirds, or red bishops (*Euplectes orix*), together with a repeated, sharp call that differs from the diurnal call, further suggests echolocation by birds, especially when these strictly diurnal birds return to perches in nearly total darkness. It should be remembered that echoes are characteristic of nearly all sounds. When played backward, tape-recorded sounds made in different-sized rooms or out of doors in the presence of trees or walls reveal a preceding echo that is usually ignored when the tape is played normally. The echo is generally interpreted as part of the originating sound and is sensed as a quality of the originating sound. Sound in a large room is clearly distinct from sound in a small room, yet we do not consciously attribute the difference to the echo. The ability to echolocate does not necessarily imply a highly specialized attainment such as that exhibited by bats and oilbirds. If man can echolocate and utilize this tal-



ent at night or when sightless, then it is likely that many nocturnal animals may also use some form of orientation derived from sensing echoes.

We know that man rarely flies in silence. Almost all our flying machines make noises. The glider hisses and the hot-air balloon is heated by a roaring and noisy flame; the propeller airplane drones and the jet plane roars. But the helium or hydrogen balloon is quiet, and in the flights of such craft we come closest to birds. The air is still because the balloon moves with the wind. Far above the ground the pilot can hear dogs barking and people talking; it seems that sound from the surface moves upward aided by an echo from the earth and travels better vertically than it does horizontally. Normally we encounter few experiences that allow us to appreciate this phenomenon. It would seem that sounds made above the earth produce a returning echo, yet I know of no experiments that have been conducted to demonstrate this. It would be interesting to put sound-recording apparatus on high-flying birds, and perhaps some suggestions can come from tests made while parachuting or ballooning. Could it not be that the sounds made by birds high in the air echo back to them and give them a perception of their height above the land?

I speculate that the sounds made by flying geese are a means of determining altitude. At night this sonar over a mountain terrain would readily inform flying birds of a valley or the rising land beneath them. I like to think that the geese calling high above Makalu are getting the signal that the summit of their flight has been reached. They are honking to localize the peaks in the darkness below them, and the increasingly distant echo that they hear coming from the jagged slopes tells them that they are safely above the highest mountains of the world. I should like to know that I am right.

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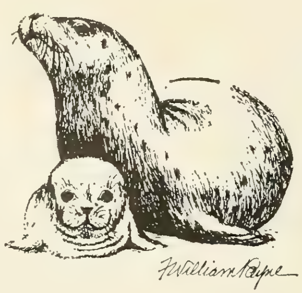

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When someone somewhere cares, someone somewhere survives.

Many Concerned, Few Committed

Continued from page 17

assumptions and values of our society and even to question the capacity of American economic and political institutions to solve environmental problems.

Most people in this sample find it easier to question social values than social institutions. This is consistent with our observations based on extensive interviews and on personal participation by research team members in conservation and ecology groups. A large majority of the NATURAL HISTORY sample (71 percent) agreed with the statement that American beliefs and values are a basic cause of our present environmental problems. The various subgroups do not differ in trend of thinking, only in degree. As might be expected, people under 30 question basic values more (77 percent), and men over 30 in the business world question it slightly less (business 61 percent, engineering 58 percent). On this point men over 30 in the professions and in government or the military and women over 30 hang together at about 70 percent.

The assumption, common in our society, that economic growth is generally good for any community is clearly challenged. Only 20 percent subscribe to this view, with 63 percent rejecting it. A slightly higher percentage (75 percent) feel that present laws and conventions governing the use of natural resources on private land are inadequate to the present crisis.

Some in the conservation-ecology movement see no connection whatsoever between an economic system based on the profit motive and ecological problems. Others hold firmly to the view that the profit motive is inconsistent with rational use of the world's natural resources. Some even see the economic system as a threat to human survival on this planet. As expected, subgroups disagreed widely on this point.

A majority of people under 30, women over 30, and men over 30 in the professions, education, and social service tend to view the profit motive as outdated. Men over 30 in other occupations trend in the opposite direction. The following table sets forth the trends of opinion with respect to the statement:

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"I believe that the profit motive in our society is now outdated and must change." Subgroups are: (1) people under 30, (2) women over 30, (3) men over 30 in the professions, education, or social service, (4) men over 30 in business, (5) men over 30 in government or the military, and (6) men over 30 in engineering or technical jobs.

	Agree	Disagree	Uncertain
Under 30	63%	22%	15%
Female, over 30	61	28	12
Male, over 30			
Professional	50	38	11
Government	42	48	10
Business	40	51	9
Engineering	36	54	10

One of the issues frequently discussed is whether or not ecological problems can be solved within the framework of existing political and economic structures. Of the NATURAL HISTORY sample, 45 percent doubt that our present system is adequate to cope with the problems, 37 percent feel that it is, and 18 percent are uncertain. Not unexpectedly, the younger group expressed less faith in the system (only 30 percent feel that existing institutions can cope). Men over 30 tend to be more evenly divided on the question. Women over 30 are closer to the under-30 group, with only 35 percent feeling that environmental problems can be solved within existing institutions.

Columnist James Reston, reporting in *The New York Times* on a meeting of business executives and professional men under the auspices of the Aspen Institute for Humanistic Studies in September of this year, pointed out that many thoughtful people are beginning to see the environmental crisis "not only as a physical and technical problem but as one that raises fundamental political, economic, and philosophical questions."

According to Reston, participants at the Aspen Institute meeting challenged some of the same values and institutions as did the respondents to this survey—unrestricted use of land and the natural resources on it by private owners, the desirability of economic growth and expansion, private initiative as the guiding principle for economic development, and "long-established concepts of the rights of private prop-

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erty in a capitalistic society." People active in conservation and ecology groups also are beginning to set their environmental concerns in a wider context of need for fundamental social change.

As we noted in our preliminary report on this project in the October issue of NATURAL HISTORY, there were some vociferous objections to our questions about political and economic issues, especially questions concerning attitudes toward other protest movements in our society. These respondents are in the minority. Most (86 percent) report that they do see a connection between all of the movements—the conservation-ecology movement, social action movements in the churches, Black Power, the student movements, and the antiwar movement. Only 9 percent felt there was no connection and 5 percent were uncertain what they thought about it. A majority (59 percent) felt that all of these were related, but separate, movements, and 27 percent felt that they were all aspects of one wave of fundamental social change.

The connection between all of these movements is not just ideological. There is an interesting amount of overlapping participation. The following table shows the percent of the total sample who report that they are active in each of four movements. It also shows the differential participation of each of the subgroups. While 60 percent of the total sample are active in organizations concerned with environmental problems, only 46 percent reported that they are active in the conservation-ecology movement. This makes sense in view of the fact that many of the environmentally concerned groups listed by respondents were civic clubs, planning boards, and organizations such as the League of Women Voters or the Boy Scouts.

During our five years of research in movements of different types, we have been able to identify five factors that are characteristic of a growing movement, even though the movements may have different goals and different means of accomplishing them. One of these factors is personal commitment. We have found that individuals who perceive themselves as truly committed to a movement, and who are so perceived by their fellow participants (and frequently by their opponents), have two things in common. First, they see their commitment as having been generated out of a subjective experience, or series of ex-

	Social Movements			
	Ecology	Peace	Student	Black Power
All Respondents	46%	21%	8%	2%
Under 30	47	30	16	3
Female, over 30	47	20	5	2
Male, over 30				
Professional	54	19	6	3
Governmental	42	15	3	3
Business	35	7	0.2	0.2
Engineering	32	6	1.3	0.3

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periences, following which they felt themselves to be radically changed—changed in the way they view themselves, as well as in the way they relate to others. We have called these "identity-altering experiences." Participants in religious movements, of course, call it "conversion." Second, they report some sort of bridge-burning act—an objective, observable event involving risk. In some way significant to him, these bridge-burning acts cut the participant off from society at large or from his previous role in it. They cut across past patterns of behavior, frequently disrupt past relationships, and identify him with a different set of values and a changed life-style.

We have found that individuals who report such an identity-altering experience and the performance of such bridge-burning acts are significantly more involved in movement activities. They interact significantly more frequently with other movement participants and have more close personal friendships within the movement.

We found, further, that there were many individuals in these movements who describe such a commitment experience, but for whom participation in the movement involved no real risk or bridge-burning act. There were others who had burned bridges but who had had no identity-altering experience. These people were more involved in movement activity than participants who had neither experience, but less so than people who had had both.

In interviewing and interacting with participants of the conservation-ecology groups, we have found the same to be true of this movement. There is also some support for these observations in this sample of NATURAL HISTORY readers. Only a small number (8 percent) of this sample felt that they had been radically changed by an experience as a participant in the movement or reported that participation had involved high risks, such as loss of job, physical injury, time in jail, etc. Of this group only 9 percent (0.8 percent of the total sample) reported both aspects of commitment. This small group contrasts sharply with the total sample and with the other subgroups in several ways.

Committed participants (as we have defined commitment) interact much more frequently with other movement participants in formal and informal meetings. If we define high interaction as three times a week or more, the proportionate interaction frequencies are as follows:

Interactions	Committed	Others
3 or more a week	72%	26%
Less than 3 a week	28	74

Committed participants are not all young (38 percent are over 30). Distribution among the various annual family income and educational categories is about the same as for the whole sample. On most environmental issues the trend of thinking of this group is the same as the whole sample, but the committed group is consistently

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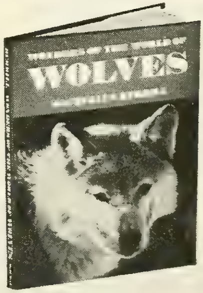

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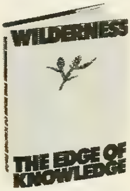

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more heavily weighted to the extreme direction. For instance, 81 percent of the total sample and 92 percent of the committed group rejected the statement that other species exist primarily for man's use and enjoyment. As for wild animals, 50 percent of the total and 68 percent of the committed would grant them an importance equal to man's.

On most issues a consistent pattern emerged—the committed group is most change oriented, young people are next, women over 30 a close third, men in the professions are fourth, and men in other occupations hold closer to moderate or conventional attitudes.

The committed group differs most in its tendency to connect social and environmental problems. Young people tend in the same direction but to a lesser degree. Responses to the statement "I think that pollution and racism are both part of the same basic problems in our society" were as follows:

	Agree	Disagree	Uncertain
Over 30	41%	47%	12%
Under 30	52	31	17
Committed	68	25	7

The differences are even more apparent in the way these three groups view the relationship between various movements within our society. A much higher proportion of the committed group see the ecology movement as part of a broader movement of social change. In addition, a much higher percentage of the committed group is active in the other movements. In the following table (A) represents the view that all of these movements are aspects of a single wave of revolutionary change, (B) the movements are related but separate, (C) there is no connection between them, and (D) undecided. There were no really important differences between the over-30 subgroups on this question.

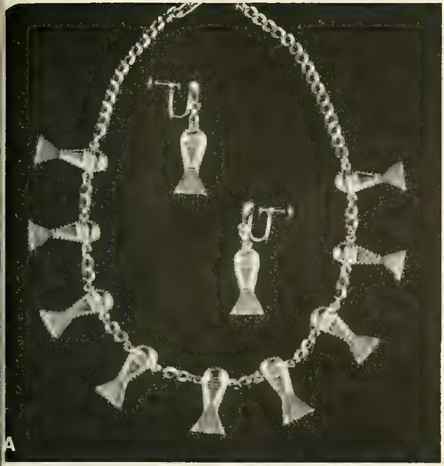
	(A)	(B)	(C)	(D)
Over 30	23%	61%	11%	4%
Under 30	35	55	5	5
Committed	73	23	0	5

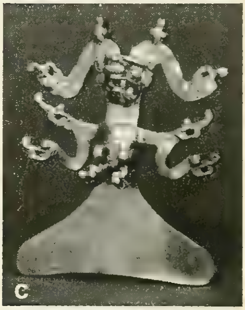
A mood of activism prevails among conservationists. Not surprisingly, 77 percent of the committed group approves of quite radical means to accomplish environmental goals. About half of the under-30 group approve of civil disobedience, while largely rejecting violence. But interestingly, 41 percent of the people over 30 approve of civil disobedience for exerting pressure on environmental decision-makers. Again, important differences occur between subgroups of the over-30 sample. More of the women over 30 and men in the professions, education, and social service approve of civil disobedience than do men in other occupations. In the following table "conventional means" includes writing letters to public officials, appearing at hearings, legal action, consumer boycotts, and peaceful demonstrations. "Civil disobedience" includes nonviolent direct action, such as sitting down in front of bulldozers or sitting-in at governmental agencies or in private businesses to enforce demands. "Violence" means such destructive action as sabotage or bombings, if other means fail. Only the most extreme measure indicated by a respondent was tabulated.

	Conventional means	Civil disobedience	Violence
Committed	23%	35%	42%
Under 30	34	54	12
Female, over 30	55	43	2
Male, over 30			
Professional	54	41	5
Government	61	34	5
Engineering	68	30	2
Business	71	27	2

In view of the current concern about youthful proclivities toward violence, it is interesting to see that for this sample a willingness to use violent means is less related to age than to what we have defined as commitment experiences.

In summary, then, environmental concern is generating changes in attitudes about man's relationship to nature, is raising serious questions about some basic assumptions in Western society, and is inspiring efforts to make changes in life-style. These changes are minor ones for most, major ones for some. For many, the concept of ecology is expanding to include the social as well as the natural environment. On all of these issues, differences in attitudes are not so much a function of age as of the degree of commitment. ■





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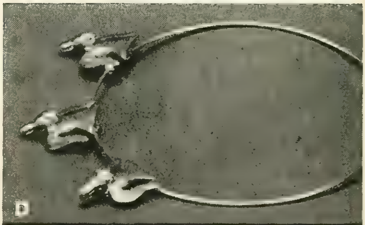

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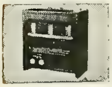

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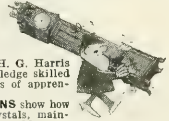

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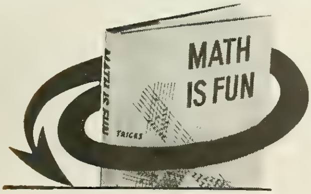

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the description applies in this respect, the question still arises of differences between the nobility and commoners of one place and those of another. Sahagún, however, was no less an accomplished ethnographer because his work does not provide all the answers. Actually, some such questions may be resolved when the earlier versions are fully translated and available for close comparison with the *Florentine Codex* and Sahagún's own Spanish version. As it is, Dibble and Anderson have advanced the cause immeasurably.

In his method and execution of the work, Sahagún emerges as the indisputable founder of ethnographic science. Employing native informants, accommodating himself to their style of discourse, using their language, checking and rechecking the responses, his legacy is more than a landmark, rather, it remains an exemplary model of the art. By selecting the elders as informants, the *Florentine Codex* is a firsthand account by men who witnessed the era of greatest Aztec expansion, the coming of the Spaniards, and the upheaval that altered the course of their civilization forever. While native picture writing preceded the written text, the product nevertheless was an account with full pictorial illustration. These paintings depict all manner of things covered in the text: the gods, their temples and the mode of sacrifice, the manner of dress, the weaving of textiles, the preparation and planting of fields, the vendors of the market, the kings and lords of the realm, the plants, the wild animals, the insects and the treatment of bites, a lazy farmer and a bad woman, the battle scenes of the Conquest, and countless more. Sequential events and processes are indicated by means of a series of interrelated drawings. The *Florentine Codex* contains over 1,800 drawings, photographically reproduced by Dibble and Anderson from the only color edition of the codex ever published, that of Paso y Troncoso of 1905–07. These black-and-white reproductions of the color plates are, of course, useful, but color symbolism was most important in ancient Mexico. The color ascribed to every aspect of a god's mask and attire, for example, holds meaning—so that color reproductions are less luxury than necessity. With respect to the drawings, it is interesting to note that while those of the *Florentine Codex* were copied in Sahagún's time from the original Tepepulco drawings, the former are done in a style exhibiting much more European influence. Thus, toenails are added to the human figures, for example, and a few cherubs and other doodles were occasionally added by the copying artist, who undoubtedly was not so native as were the original informants.

Book 6, *Rhetoric and Moral Philosophy*, appears to have been written about 1547 in the town of Tepepulco well prior to Sahagún's commission to write the general history. It may in fact have been the catalyst for his later assignment. In any case, it is written in the "polished" language of Texcocan Nahuatl, the standard for proper speech for all of ancient Mexico. It is a volume of prose and poetry that unveils the heart and inner thoughts of the people more than anything ever written about them or in their language. To his critics, who thought it a pack of lies, Sahagún replied, "What is written in this book is beyond the human mind, a mortal man could not invent the language which is found in it."

Book 6 contains 43 chapters: prayers to the gods, exhortations of the rulers, a few adages, riddles, and metaphors. Much of the content is ritualistic, extremely formal—prayers and exhortations learned by rote and passed down from generation to generation in the *calmecac* or *telpuchcalli*, the schools of Aztec society where the young received formal instruction. Most of the volume would seem to pertain to higher society—the rulers, the nobles, the well educated—but the sayings and the riddles are colloquial expressions known to all, rich and poor, noble and commoner. The contents of the volume might have differed somewhat were it to have derived from a place other than Tepepulco—thus, the great god Tezcatlipoca, so prominent in

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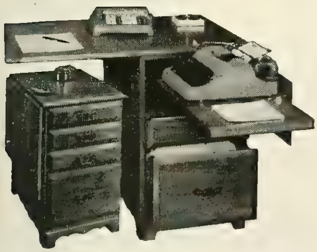

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Book 6, was especially revered there, as had been Quetzalcoatl in ancient Tula, or Huitzilopochtli in Tenochtitlán. Tlaloc, Lord of the Rain, however, was everywhere revered.

Sahagún's work was controversial. The contents of Book 6 alone indicate why. In Aztec thought, as expressed in this prayer to Tezcatlipoca, man was by nature weak and required divine guidance. To ascribe such concepts to idolatry bordered on heresy.

> Verily, that which a man will do, that which he will perform to attract thy wrath, thy anger, thy annoyance, to stir up castigation is not his doing. Open his eyes, open his ears, advise him, set him upon the road, guide the commoner. Consider not only the commoner, the laborer; consider the governed. Verily, now, inspire him, animate him, for thou makest of him thy seat, for he is as thy flute. Make him thy replacement, thy image.

There is also a profoundly universal quality to Aztec thought as it is so simply and eloquently expressed in the wisdom imparted by a father to his daughter when she reached the age of discretion:

> Hear well, O my daughter, O my child, the earth is not a good place. It is not a place of joy, it is not a place of contentment. It is merely said it is a place of joy with fatigue, of joy with pain on earth; so the old men went saying. In order that we may not go weeping forever, may not die of sorrow, it is our merit that our lord gave us laughter, sleep, and our sustenance, our strength, our force, and also carnal knowledge in order that there be peopling.

Then, of course, there is a lighter side—the riddles:

> What is that which says: "I go this way, thou goest that way, so that we shall meet there?" The breech cloth.
>
> What is that which enters the forest going with its tongue hanging? The axe.
>
> What is that which becomes pregnant in only one day? The spindle.

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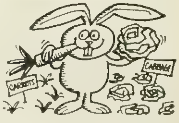

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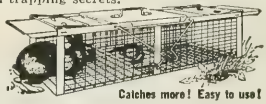

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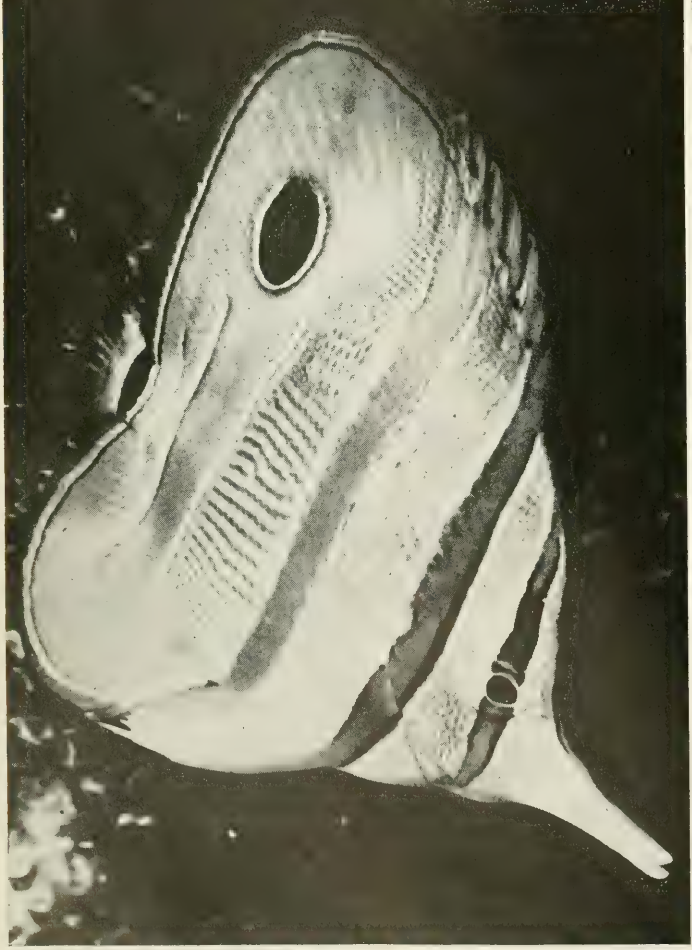

Despite their success, their power, one of the striking things about these people was the air of pessimism and gloom, the feeling of anguish, the fear of destruction, a fear for mankind that always lurked in their thoughts. It is no better expressed than in the haunting prayer to Tlaloc, the Lord of the Rain, greatest of the gods:

> May it soon come to pass, to happen — that which the old men, the old women come knowing, come guarding; that that which is above us will fall in; that the demons will descend, will come to destroy the earth, will come to eat the common folk; that there will be eternal darkness on earth; that nowhere will there be people on earth.

And while the Aztec way of life perished as their prophesies had warned, we are much the richer today for a poor friar's toil and for Dibble and Anderson's effort in making this masterful work available to the English-reading world.

Dr. Harvey is associate professor in the anthropology department at the University of Wisconsin at Madison.

THE BOOK OF IMAGINARY BEINGS, by Jorge Luis Borges. Translated by Norman Thomas di Giovanni. *E. P. Dutton & Co., $6.95; 256 pp.*

The author, famous in the Spanish-speaking world as a poet, storyteller and litterateur, and his collaborator, Norman Thomas di Giovanni, disarm the reader of their handbook of apocryphal biology by announcing at the outset: "There is a kind of lazy pleasure in useless and out-of-the-way erudition." Although the title imposes no limits and might justify the inclusion of any creatures conceived by the human imagination, from Prince Hamlet to "each one of us and . . . the god-head," it refers actually to a collection of one hundred and twenty sketches in which the fantastic zoology of the bestiary is revisited by a sophisticated and scholarly contemporary. Some of the sketches are as brief as a single page; none is longer than three pages. All are presented with the deceptive simplicity of a chiseled stylist and the learning of a world scholar who is, among other things, Director of the Argentine National Library. Also present are the philosophic overtones

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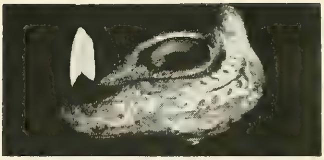
Entering Mr. Borges' zoo of sphinxes, griffons, and centaurs, one is clearly in the demesne of literature, not science, unless it is argued that mythology and folklore should be subsumed under anthropology. In any event, here are beautifully delineated, quick vignettes of some of the legendary beasts we have heard of—the basilisk, behemoth, chimera, and hippogriff; the deathless phoenix; the pelican, which, according to medieval fable, "opens its breast and feeds its young with its own blood"; and several fearsome creatures from the oral traditions of the United States, such as the hidebehind, which devours lumberjacks in the north woods but cannot be described because it is always hiding behind something.

Regrettably absent is the sidehill hoofer, or to give it its scientific name, *Membri-inequalis declivitatis,* which grazes in hilly country and by a marvel of adaptation has two long legs on the downhill side and two short legs on the uphill side. If it turns the wrong way, the hoofer, or gouger, as it is sometimes called, falls and breaks its neck. Extensive paleozoological remains have been reported from Marion County, Arkansas. Unknown to the present reviewer, at least, although it is mentioned by Borges, following Pliny, is the remora, a sucking fish that can hold a ship fast by "a cartilaginous disk with which it creates a vacuum. . . ."

The charm of this book, judged by the standards it sets for itself, can be properly conveyed only by quotation. Let us take up the case of the squonk, *Lacrimacorpus dissolvens.* Its range is limited to the hemlock forests of Pennsylvania, and it is so morbid in temperament that "hunters who are good at tracking are able to follow a squonk by its tear-stained trail, for the animal weeps constantly. . . . Mr. J. P. Wentling, formerly of Pennsylvania, but now at St. Anthony Park, Minnesota, had a disappointing experience with a squonk near Mount Alto. He had made a clever capture by mimicking the squonk and inducing it to hop into a sack . . . [but] suddenly the burden lightened." When the squonk hunter investigated his bag, "There was nothing but tears and bubbles."

The author, content to present his zoological mythologies descriptively, does not attempt to pull them together into any general synthesis. "We are ignorant of the meaning of the universe," he writes, adding only this concession, that "there is something in the dragon's image that fits



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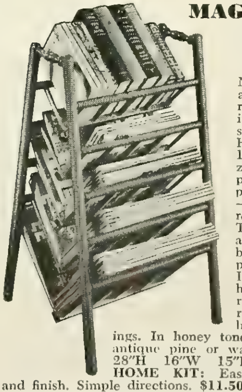

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man's imagination. . . ." But this distillation from "old authors and abstruse references" nevertheless deserves a place on a special shelf, nearer to poetry than biology, together with such good companions as T. H. White's *The Book of Beasts* and *The Most Wonderful Animals That Never Were*, by the recently mourned Joseph Wood Krutch.

GERALD CARSON

AMERICA'S LAST WILD HORSES, by Hope Ryden. *E. P. Dutton & Co., $8.95; 311 pp., illus.*

In 1968, plans were under way to destroy a small herd of wild horses in the Pryor Mountains area of southern Montana when an indignant John Walsh, of the International Society for the Protection of Animals, telephoned Hope Ryden and informed her of the threatened destruction. It was a news story, and Miss Ryden, in her capacity as a feature producer for ABC Evening News, responded to it as she had on previous occasions. She investigated; she researched the background; she became personally involved. This book, with the many supporting photographs she made of wild horses in the field, is her easy-reading report. It is mostly a history of North America west of the Appalachians, seen through "horse-colored" glasses.

Hope Ryden's book attempts none of the Texan literary style that the late J. Frank Dobie wrote into *The Mustangs*. It mentions only superficially the fossil evidence that George Gaylord Simpson presented so well in *Horses*. Its focus precludes the light, deft, fictional form of the family books about horses by Marguerite Henry, who writes for younger audiences. Instead, *America's Last Wild Horses* appeals to the sentiments of horse-loving adults who can be alarmed into action by learning how free horses in the New World are rapidly being killed, cut up, and processed for dog food. It stresses that for *Equus* this is a second decline, the first having been completed at the end of the Ice Age when Amerindians all the way from Alaska to Patagonia could include horsemeat in their diet. Horse bones are among the charred remains of their ancient campfires, but no one yet knows from the fossil record when the last wild horse in North America disappeared.

The first of the new wave of horses to reach America came aboard the ships of Christopher Columbus's second expedition. Left in the West Indies as breeding stock, these and similar animals from southern Europe gave the small bands of Spaniards an uncanny power over the Amerindians they met. "The survival of these animals was a life and death matter to the cavaliers. Cortés plainly stated that he valued the life of one horse above the lives of twenty men." But not until after 1600, when Juan de Oñate tried to settle with his livestock near the site of Santa Fe, did the Indians learn how to ride and care for horses—and carelessly let many animals escape to form nuclei of feral herds. The Indians were "reckless with the providential supply of Spanish ranch animals from which they could always replenish their losses."

Among the descendants of these animals introduced by the Spanish, a surprising number in the western mountains have maintained a degree of genetic isolation. Despite sporadic dilution by recent recruits from modern breeds of horses, a few retain the five large lumbar vertebrae that characterized the backbone of the original stock. It goes with a zebra striping on the legs of newborn foals, which has otherwise been lost in the intervening centuries. By comparison, Arabian and Andalusian breeds of modern horses have a five-and-a-piece series of lumbar vertebrae, and the remaining man-made, or "tinkered," horses in our world have six large lumbar vertebrae. Nearly 200 individuals (although never more than 20 mares at a time) have been certified as Spanish mustangs with five lumbar vertebrae by the Spanish Mustang Registry, which was established in 1958 and is directed solely toward the restoration of the lost breed.

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Other associations interested in America's wild horses are almost as numerous as the names by which these animals go: broncs, broomtail horses, cayuse or Cheyenne ponies, Indian ponies, cow ponies, cutting ponies, estrays, mavericks, and mustangs in the United States and Canada; *baguales* in Argentina; *criollos* in Chile. A National Mustang Association (Salt Lake City, Utah) aims to conserve and control all wild horses still in America, and to grade each captured animal according to how much Spanish blood it appears to carry. The American Mustang Association (Phoenix, Arizona) maintains a registry and seeks to breed up to a standard size and conformation the animals that are recovered from the wilderness. Humane treatment of the surviving wild horses is the sole aim of the International Society for the Protection of Mustangs and Burros (Reno, Nevada) and of the Canadian Wild Horse Society (Richmond, British Columbia). All of this agitation comes at the last moment, for from an estimated two million wild horses in the American West at the beginning of the century, the number fell to a million in 1926, to 150,000 in 1934, to 33,000 in 1958, to 17,000 in 1967, and continues downward.

Hope Ryden, chronicling the mismanagement of this living resource, shows why the "Wild Horse Annie Bill," passed by Congress in 1959, does not insure a future for these animals. Her hope is that more wild horse refuges will be established, similar in concept and planned management to the one she helped stir Stewart Udall to set aside in the Pryor Mountains in 1969. Her call is for an informed public to press for realistic cooperation between the Bureau of Land Management, the Fish and Wildlife Service, the National Park Service, and state agencies to halt the butchery of wild horses before they disappear again.

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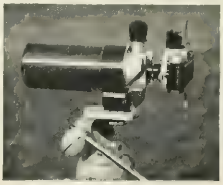

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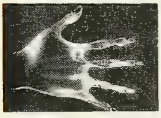

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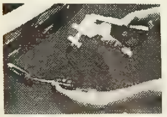

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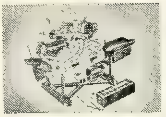

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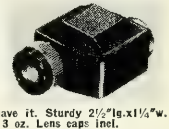

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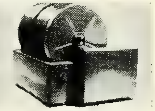

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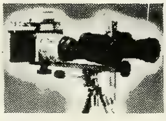

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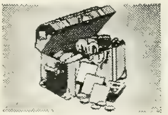

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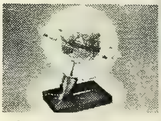

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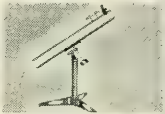

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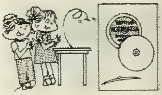

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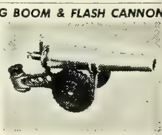

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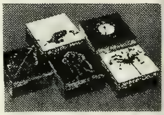

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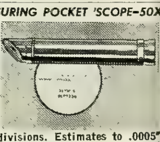

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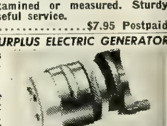

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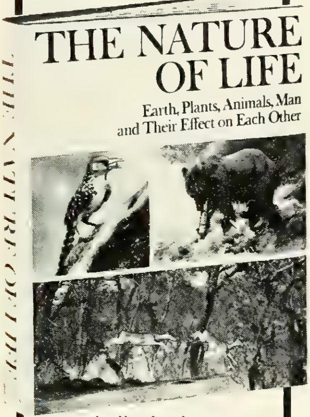

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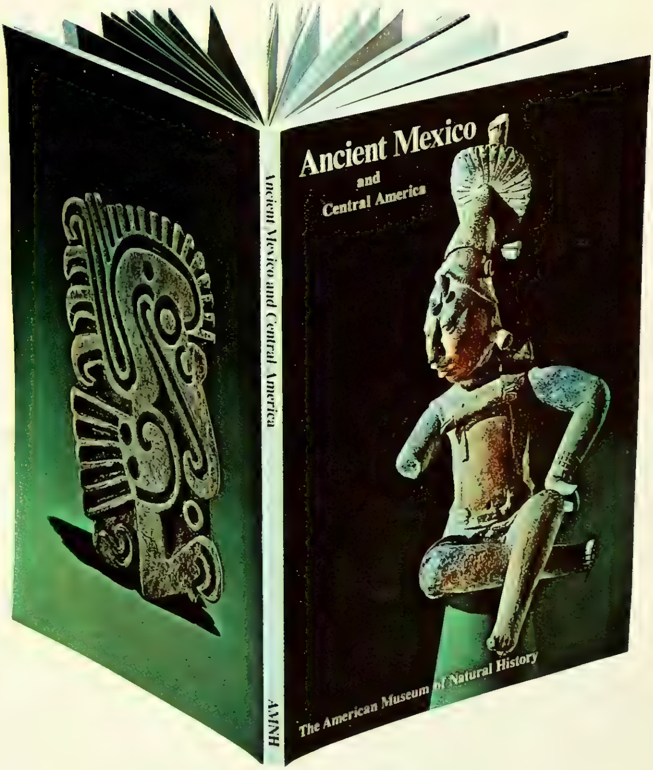
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